# CALIFORNIA SCHOOLS

JUNE, 1958

# CALIFORNIA SCHOOLS

VOL. XXIX, No. 6
JUNE, 1958

Official Publication Issued Monthly by the California State Department of Education

Entered as second-class matter May 8, 1930, at the Post Office at Sacramento, California, under the Act of August 24, 1912.

ROY E. SIMPSON
*Superintendent of Public Instruction*

EDITOR
IVAN R. WATERMAN
*Chief, Bureau of Textbooks and Publications*

EDUCATIONAL PRESS ASSOCIATION OF AMERICA

## CONTENTS

| | Page |
|---|---|
| California Conference on Science and Mathematics Education in the Public Schools | 283 |
| Purpose of the Conference, *Roy E. Simpson* | 284 |
| Education in an Age of Technology, *Howard A. Meyerhoff* | 286 |
| Needs of Our Armed Forces for Persons in Scientific and Technological Fields, *Kermit Mohn* | 291 |
| The Nation's Manpower Needs: A Challenge to Education, *Aryness Joy Wickens* | 299 |
| Science and Mathematics Education as Viewed by a California Business Executive, *H. L. Hoffman* | 307 |
| Science and Mathematics in the Elementary School, *Harold Spears* | 311 |
| The Present Status and Future Needs of the Science and Mathematics Program in California Secondary Schools, *Nolan D. Pulliam* | 316 |
| Post High School Mathematics, Science, and Engineering Programs: Present Practices, Trends, and Implications, *Ellis A. Jarvis* | 323 |
| Matching the Schools' Products to Society's Need, *Jay Davis Conner* | 329 |
| The Education of Science and Mathematics Teachers, *J. Burton Vasche* | 335 |
| Education in Our Age: Let's Define the Problem, *Glenn T. Seaborg* | 339 |
| Reports and Recommendations of Section Meetings of the Conference | 351 |
| Summary of Conference Achievements, C. C. *Trillingham* | 362 |
| Education Looks Ahead, *Roy E. Simpson* | 367 |
| Departmental Communications | 369 |
| For Your Information | 370 |
| Directory of California State Department of Education | *inside back cover* |

# CALIFORNIA CONFERENCE ON SCIENCE AND MATHEMATICS EDUCATION IN THE PUBLIC SCHOOLS

The California Conference on Science and Mathematics Education in the Public Schools, called by Roy E. Simpson, Superintendent of Public Instruction, was held in Sacramento on February 24 and 25, 1958.

## GENERAL PURPOSES

The conference was called to examine the needs for science and mathematics education and to appraise the contributions of the public schools in meeting these needs.

## SPECIFIC PURPOSES

Identify the needs of our state and nation for science and mathematics education.

Receive reports on the status of science and mathematics education in California public schools.

Determine the extent to which the current program of instruction is meeting the needs for science and mathematics education.

Propose means to meet the requirements for science and mathematics education.

Invitations to the conference were extended to the members of the State Board of Education, presidents of California institutions of higher learning, representatives of government and armed services, publishers and editors of newspapers, executives of radio and television stations, and representatives of business, industry, science, lay organizations, and 30 education associations. Over 200 representatives of these organizations participated in the conference.

The first day of the conference was devoted to two general sessions in which the purposes of the conference were discussed and talks were given by leaders in education and in the fields most directly concerned with the problem of securing manpower that is well trained in science and mathematics. Section meetings were then held during the morning of the second day of the conference to provide opportunity for each participant to discuss the various purposes of the conference and for the participants in each section to make such proposals as they thought feasible as means of furthering the purposes. The final general session of the conference, held during the afternoon of the second day of the conference was devoted to the section reports and to summarizing the activities of the conference. A complete report of the conference, including the full texts of the talks that were given in the general sessions, and the reports made by each of the section meetings, is presented in this issue of *California Schools.*

## PURPOSE OF THE CONFERENCE

**ROY E. SIMPSON, *Superintendent of Public Instruction***

I have called you here for a very definite purpose. All of you have come at your own expense in time, energy, and money. We have received great encouragement from all who have agreed to participate. Some financial assistance, other than that given by the state, has been made available by business and industry to assure the success of this conference.

I want to outline the purpose of the conference. Long before the Soviet satellite jarred the complacency of the American public and caused it to have an acute case of nerves, our public schools were giving special attention to meeting the increased need for concentrated training in the physical and technological sciences. The manner in which the training has been given and the extent to which it has been given will surely be discussed during this meeting by some of our speakers. We must, however, keep in mind that our need for educated men and women to build a nation in which we can continue to live as Americans is independent of any competition with the products of the Russian philosophy.

The distinct advantage, however, of the current new sense of urgency in education is evidenced by our willingness to come together at this conference. We need to share our experiences and our opinions in an attempt to develop the constructive conclusions and recommendations most beneficial to the entire field of education. These conclusions then may be circulated throughout our state so that others may analyze them and choose those recommendations most useful for their own schools. We do not anticipate that we shall learn all the answers at this one conference.

This inventory taking will reveal some very startling things to all who are ready and willing to examine our school program carefully. We shall take a look at the situation from the national, state, and school district points of view.

All here are aware of the impact that the big increase in the California school population has had upon our schools. We have consistently told the public about the need for more buildings, more competent teachers, and, of course, more money—all of which must be forthcoming if we are to play fair with the youth of California.

During this conference we shall accept known facts about teacher shortages and other school needs based on population growth, in order to give emphasis to the curriculum program.

We need to look, then, to see where we can improve upon that which we now have. For several years, summer school fellowships emphasizing special study in science have been offered to teachers by industry. Students have been encouraged to compete for science achievement awards. Since 1942, almost a quarter of a million boys and girls have participated in one company's science talent search program. Many of the participants have been awarded significant scholarships.

We want to know the other things that are being done. We desire to know the opportunities, needs, and responsibilities at local, state, and national levels.

Basic to all our study here is the need for developing a complete change in the attitude of the public toward those who are capable of high intellectual

attainment. Study must be encouraged in the home. Rest and recreation may be important to our way of living, but there must be recognition of the need for more vigorous application of intellectual capacity for those blessed with the urge to learn.

The great recent concern of the public would lead some to believe that teachers have never been concerned about the impact of a situation in which the many attractions available to the youth of our country compete with learning the so-called fundamental subjects. Let us keep in mind also that there is always room for improvement.

Permit me to point out that I do not advocate the adoption of the Soviet system of schooling for our American youth. We are all really striving for freedom. Peter J. Schenk, President of the Airpower Council, said recently:

"Freedom, after all, is more than sharing American beliefs—true freedom is the freedom of self-determination—the lack of any ideology imposed from above or from outside on a submissive people by force or by barter."

It has always been somewhat of a mystery to me to witness the way in which the emotions of the public can be easily diverted by some statement implying conditions that really do not exist. We must remember that our nation today is the fine nation it is because we have built a citizenship through a sound educational program. We need to give attention and encouragement to those things that are right about American education.

Improve education, yes, but remember that no nation, state, or local community will ever have an educational system stronger or better than it is willing to help build and support.

May these few remarks serve to stimulate a variety of reactions and lead us into the purposes of the conference, which are as follows:

1. To identify the needs of our state and nation for science and mathematics education
2. To receive reports on the status of science and mathematics education in the public schools of California
3. To determine the extent to which the current program of instruction is meeting the needs for science and mathematics education
4. To propose means whereby all needs for science and mathematics education can be fully met

Alfred North Whitehead has said, in part, and I quote: "In the conditions of modern life the rule is absolute, the race which does not value trained intelligence is doomed . . . Tomorrow science will have moved forward yet one more step, and there will be no appeal from the judgment which will then be pronounced on the uneducated."

In all our thinking let us be sure to keep our balance. We are truly in an era of decision.

## EDUCATION IN AN AGE OF TECHNOLOGY

**HOWARD A. MEYERHOFF,** *Executive Director, Scientific Manpower Commission*

I feel I have a peculiar advantage in that I presented only a digest of my talk. I've been informed by members of the press that it's already been filed, so I assume I can say what I please now. And if I deviate from the text, I think you will understand that any resemblance to the text and what I say is purely coincidental. After all, there is in this vital subject a certain number of facts that I can't alter, there are a certain number of truths and principles that will remain unchanged, and the deviation will merely be in presentation.

I do believe we suffer from psychological inertia in a most serious way. That is evident in our military and educational systems, and we're seeing peculiar manifestations of it at the present time. Dr. Simpson mentioned the odd and yet understandable public reaction to Sputnik. Well, the reaction, like most reactions, has leaned over backward, gone too far, and yet now has a momentum that's difficult to stem. Perhaps the launching of our own Explorer did bring people back a little closer to earth and enable them to look at the situation of American science and mathematics with a little better perspective. It is in that better perspective that I hope we all have that I will address you today.

I do not want to minimize in any respect the reaction that occurred as a result of Sputnik. This reaction infects our Congress, and there is the serious danger of legislation that will be entirely inappropriate and unfortunate. There seems to be the notion that more scientists and more engineers should be created by the artificial means of subsidization. That's no way to create anything. You can't buy everything with money. You can pay for a lot of things with money but you're really not buying some things, particularly personnel or manpower. It is important that we channel the youth of our nation not just into science and engineering alone, but also into those positions of leadership in industry, government, and the professions that need brain power just as urgently as our nation needs science and technology. And so I trust we can look at this situation in good perspective. When we get down to the matter of training our youth, there are some very important things to say. I'm not all sorry that Dr. Simpson has said some of them for me, and if I repeat, it is merely because of their great importance and perhaps by repetition we can keep getting these points across.

We want to get away from one common attitude. I don't know whether Mr. Mohn will verify this particular event—perhaps it's apocryphal—but you may have seen the cartoon of the draftee who had just joined the Army. Here was an irate sergeant, an old line man, stamping his feet, gritting his teeth, and bellowing, "Damn it, it doesn't have to make sense, it's regulations!" Well, now, we are in a position where we want to make sense, and some of the laws that could be passed under the spell of this hysteria that infects us won't make sense; but they will become regulations if we don't watch out. I trust that the State of California will avoid the subsidization of science and technology because these areas of learning and application are doing very well. They don't need artificial respiration; a dose of oxygen won't help the situation at all. What we do need to take care of is not a shortage of engineers and scientists, but basically a shortage of teachers. Good teachers, trained teachers—two different things.

To some degree, good teachers are born, but teachers become better through training. And of course the one way to get competent teaching personnel is to develop public interest in our educational system and to remember that while you don't buy good teachers you can pay them adequately and by so paying them keep them.

First of all, we have the serious matter of identification. Indentification of prospective teachers is not easy. How are people identified for the careers into which they should go? A few studies have been made. They are rather imperfect studies, but nonetheless they clearly indicate that a far greater number of youngsters are directed into one career or another by personal contact. The impersonal contacts of books, movies, comic strips, and whatnot are just contacts with phenomena. For example: your ambition and mine in the good old days of the steam locomotive may have been to become a locomotive engineer. We watched the trains go rolling down the track and "Oh, boy," we wanted to run one. That kind of motivation is one that we usually outgrow. But it's motivation by people, the inspiration that comes from people that lasts. In the studies that have been made (I'm acquainted with three), the teacher seems to be more important than the parent. I'm one of those happy parents who can say I was more important than the teacher because my son didn't learn a thing from my example—he went into my profession too, which, by the way, is the profession of geology. I am a scientist, and still a practising scientist, I am happy to say.

The teacher has a great deal of contact with the student. It takes only one teacher to set fire to the mind and heart of a young person and get him interested; but the teacher has to have some fire himself if he is going to motivate the youngster. In the legislation before Congress at the present time, the two bills that I think will be the principal ones considered in the educational field are the administration bill and the Elliott-Hill bill. Senator Hill is from Alabama. I will not take too firm a position on either one of these bills, but may I say on behalf of the Elliott-Hill bill that among its provisions it proposes to set up loans for young people finishing high school and entering college. If these youngsters choose to go into the teaching profession, the loans will be converted into scholarships at the rate of 20 per cent per year for each year of teaching. If they decide not to teach, repayment of the loan after the student finishes college would be on an easy basis. That part of the bill has been patterned after a still more generous piece of legislation passed in the State of Ohio, where a youngster can go into teaching and cancel out the loan in two years of instruction. Well, these are ways of making the teaching profession a little more attractive. I place this matter before you because Dr. Simpson stressed the difficulty of getting good teachers.

The business of increasing classes in mathematics and increasing the number of offerings in science may sound simple on paper, but believe me, ladies and gentlemen, it is not simple. Take one case, one set of statistics that I have mentioned in my digest. I think it is so appalling a case that I should re-emphasize it by repeating it here. The National Education Association has a splendid research division. One of its researchers, Ray Maul, conducts an annual survey of the teacher situation, listing all the new teachers that come into the profession in all the states. Now, here are some of the distressing facts. In one of his surveys, Maul has complete statistics for 29 states, and in those 29 states there was a need for 1,919 instructors in mathematics. When the smoke cleared, they had

1,047 men and women who had been trained in mathematics. They had 1,919 people to face classes, but 872 of them were not trained in mathematics. Among those 872 there were 14 music teachers. Now offhand you might feel sorry for the students who faced those music teachers, but I feel sorry for the music teachers. Just think of someone interested in music being told by the school superintendent, "Well, we don't have a mathematics teacher—you're it." You see the shortage?

We're not short of miscellaneous people particularly. We seem to get teachers somehow. I don't know how, frankly, because I've never had to face the problem. Nonetheless, too often they are persons with a certain amount of training in how to teach, and they're told, "You go in and teach this or that." If it's mathematics, then you can understand another statistic which is rather appalling: that only 52 per cent of the young men and few young women who enter engineering schools graduate with a Bachelor of Science degree in engineering. I submit to you that this is one of the most colossal wastes that we have in the United States today whether we are dealing with the whole problem of conservation of resources or conservation of our most fundamental resource—brainpower, manpower.

It means, as you can see, that a great deal of time is taken up—and space and facilities too—to try to teach 48 per cent that won't make the grade. I assure you, not all of them drop out for reasons of scholarship. We don't know the per cent, but it is somewhat more than half of the 48 per cent that just don't get by freshman mathematics. Why? Because only 1,047 mathematics teachers were found to fill 1,919 posts. You see, that's no reflection on the schools. It's a reflection on all of us. Who are the people who should be looking for teachers, should be paying them, and should be rewarding them with the social position that teaching should command and does command in countries other than our own? We should, I'm sure, give a little more honor and glory to the "egghead," to the "brain,"—not necessarily the "grind," for the "grind" is an awfully dull person, but certainly to the "brain," who is often a brilliant person in more areas than just scholarship.

Perhaps, because of the necessity for mass education, we have placed too much emphasis upon conformity. We have not given enough attention to raising standards. I think we underestimate the mental capacity of our youth. May I give you an example. Thanks to Mr. Mohn's Department of Defense, I was given one of those plush tours of military installations a little less than a year ago. At the Keesler Air Force Base in Mississippi I had my eyes opened to the possibilities of American youth by a mathematics teacher who was there to train technicians in electronics—to train them to take over the very important technical work that must be done in that field in the Air Force. Here was his very extraordinary story: the men are screened carefully, of course, before they get into that particular Air Force Base; therefore he has a group with a high level of intelligence but rarely anyone who has had more than a high school education—young men ready to go to college, in short. This teacher told me that he can take any group of 100 without further screening and he'll get only 6 per cent who fail. In six weeks he reviews elementary algebra and teaches them advanced algebra, trigonometry, and the beginnings of calculus. There isn't much need for geometry, but he teaches what little is necessary. In six weeks those men go out of there ready to apply all they have learned. He has never questioned their ability to absorb these subjects. Too often we question the ability of our

students to absorb material that we might place before them; but that teacher never questions it and he gets only 6 per cent failure, whereas engineering schools are losing 48 per cent.

I think that we must chop that waste in half, by reducing the 48 to 24. Let those who find they're miscast in engineering depart; they're much better off, and so is engineering. They may make the discovery too late; in fact, some might even complete an engineering course and find they're not fit for the kind of life it requires. The best thing for them to do is to leave the field even though such an action once they have a degree may come late and may be difficult. This sorting process may take care of about 24 per cent of our engineering classes. I'm guessing at the figure; that's not an accurate statistic. But if we save the other 24 per cent by a good background of precollege training, we don't have to worry about shortages of engineers and scientists because every one of these youngsters, if he persists in his course, will be an engineer of a sort. We need several kinds. We need the leader type. We need the competent run-of-the-mill engineer, too—perhaps not much more than a super-technician, but nonetheless the "super" part counts, as many of you know full well.

There's the cure for our shortage. The shortage isn't particularly acute at this moment, but we may expect it to be acute once again, perhaps within the limits of the year 1958 if our research and development programs get going as fast as some of us in Washington believe they will. Here then, I think, is where we can concentrate our efforts and our energies effectively: the matter of teachers. I wish it were a simple job just to put ads in the paper and have them all flock in, all trained, all competent, ready to do their jobs. But we have to start, not only in recognizing the teacher as a person of some importance in our community, in our economy, in our national welfare, but also in assuring the teacher, in fact in assuring everybody, of the best training possible from the elementary school upward because right now, with our elective system, which is worse in some states than in others, many are electing themselves out of careers. I'm not competent to comment upon the system in California; perhaps the governor did that for you in his speech yesterday. How accurate that was, I have no means of judging. But remember this: if a youngster who has what it takes to become a scientist or an engineer misses out on the basic mathematics that he must have to enter college, he has eliminated himself from a career that he should follow. That elimination, you see, is too accidental for us to take with any equanimity. This calls, you see, for a system whereby no one will be self-eliminated by that hit-or-miss process. It calls, among other things, not only for good instruction in mathematics but also for good guidance, excellent guidance. We always hope our youngsters' parents are good guides, but are they? We must be sure that there is supplementary guidance available in the schools. I think with horror of a school in New York State that has one student counselor for 1,200 senior students. You can judge how much counseling the youngsters get in that situation. The teacher then becomes more influential because the counselor under such circumstances cannot do all of the job. Here is where the teacher is recruited too—recruited through identification and selection by good counselors, good parents, and good teachers in one subject or another. Then these young people will get the encouragement they need to enter the teaching profession. We need teachers at all levels.

Our most serious situation is in the teaching profession, from the kindergarten to the university. And it will become worse. Our population, as you know, is

bottom-heavy. We've had a surge of births, starting about 1937 and gaining momentum in the forties. This surge is now overwhelming our high schools. It will very quickly hit our colleges.

We are also facing another situation that has hit our colleges already. More and more people wish to get college educations. As much as 31 per cent of our high school graduates are now continuing on into higher education—a very substantial per cent, as you can see. Already we have the largest college and university enrollments in our history—incidentally with more students paying their own way than ever before in our history. Therefore, even now there is the pinch upon college and university faculties that we've known for years at the elementary and high school levels. So I submit to you, if we attend to the problem of teachers, look what we'll get—good guidance, with the identification and the motivation of our young people to go into science and engineering and into any other field where leadership is needed. And we will get a reduction, though not the elimination, of that ungodly waste of teacher time, classroom space, and classroom facilities that occurs with an attrition rate of 48 per cent. Here is where we need conservation—not the conservative type of conservation where we sit back and hold everything. It calls for a vigorous program in which every citizen is involved.

I think of a young man who made a success of business. His commitments kept getting greater and greater. He nearly always traveled by air or by car, and he had never been overnight on a train. He lived in Chicago. One of his friends said to him one day when the planes were grounded, "Why don't you take the Century into New York? You've got to get there in the morning. It's a fine train." "Well", he said, "Maybe I will". So he got a few pointers on what to have with him in his berth, got on the train, and went up to the porter and asked, "Porter, ah, what is your average tip?" The porter never batted an eye. He said, "Five dollars, sir." Well, next morning he got off the Century and gave the fellow a five-dollar tip. The porter beamed. "Thank you sir, thank you! You know, you're the first passenger what's come up to the average in five years."

Ladies and gentlemen, we've got to come up to a pretty high average. Let's get to it.

# NEEDS OF OUR ARMED FORCES FOR PERSONS IN SCIENTIFIC AND TECHNOLOGICAL FIELDS

KERMIT MOHN, *Office of the Assistant Secretary of Defense (Manpower, Personnel, and Reserve)*

I appreciate the opportunity of being here to participate in your conference to evaluate the educational needs and resources of your famous state. Education is a very live topic with us in the Department of Defense.

Before launching into a description of the need of our armed forces for persons trained in science and mathematics, it is appropriate that a frame of reference be established.

## Total Military Manpower Requirements

Our armed forces today number approximately 2.6-million. All but a very small fraction of this number are men. To maintain current strength, the armed forces will continue to require large numbers of new personnel each year to replace those separating due to completion of tours of duty, retirement, or other causes. The precise number cannot be forecast with any great accuracy, on a long-term basis. Quite apart from possible fluctuations in armed forces strength, the annual replacement requirement will be affected by changes in re-enlistment rates, by changes in the services' ability to recruit personnel for long-term enlistments (as against two-year draft terms), and by other factors.

On the basis of recent experience, we estimate that the armed services will have an average annual requirement of about 600,000 young people from civil life for the next few years. These will enter service through enlistment, induction, or appointment.

In addition to the annual requirements of the active branches of the armed forces, we estimate that possibly between 50,000 and 100,000 young men per year may choose to fulfill their military obligations through enlistment in the Reserves or National Guard under the 6-months active duty training program. Thus, the flow of manpower into the armed forces may be between 650,000 and 700,000 per year.

Our present ability to meet these annual requirements is based on continuation of a military service and training liability, as provided under current selective service legislation. Under our military manpower procurement system, we seek volunteers first, and use the selective service draft to provide the balance of the requirements which cannnot be obtained through voluntary programs. During the fiscal year ending June 30, 1957, the armed forces acquired 660,000 young people. Of these, 480,000 were volunteers and 180,000 were inductees.

Of course, the measure of the manpower need for Selective Service is not fully indicated by these figures alone. We know that many of the volunteers enlist in preference to waiting for induction, in order to choose a particular branch of military service; a particular type of training; or a particular time of service. There is no doubt also that many persons enter ROTC and similar college programs in order to qualify as officers; or in lieu of being inducted as enlisted men. Finally, Selective Service is a definite stimulus to certain Reserve programs.

Considering the magnitude of our annual requirements, let me stress two points. First, under present conditions, Selective Service will continue to be necessary because experience shows that we have not been able to maintain active forces of today's magnitude by voluntary recruitment alone. Second, military training and service will continue to be a part of the normal life of most qualified young men.

Up to this point, I have dwelt on the over-all quantitative aspects of manpower requirements of the armed forces. I shall now turn to the qualitative side, which is of primary interest to this group.

### Requirements for Specialized Personnel

Any consideration these days of the needs of the armed forces for persons with background in science and mathematics, generally brings the words Sputnik and Explorer into the discussion. These satellites have, of course, dramatically demonstrated our existing national need for substantial and continuing improvement in the supply and quality of professional and technical manpower. It is common knowledge that persons with these skills are at a premium in scientific laboratories and in industries which conceive and produce missiles, atomic submarines, and other highly complex weapons systems. Not so well understood is the fact that the use of these advanced weapons systems in the armed forces also requires a progressively larger proportion of specially trained men. At the present time, about 45 per cent of all jobs for enlisted men are in highly technical areas which require varying degrees of scientific and mathematical capabilities. In comparison, this group accounted for about 34 per cent of all enlisted men's jobs in World War II, and about 40 per cent during the war in Korea.

This broad technical group includes electronic technicians, aircraft and engine mechanics, electrical equipment repairmen, air traffic control operators, medical and dental technicians, and the like. Increases in requirements have been particularly pronounced in highly complex fields, such as radar and armament systems maintenance; and completely new requirements have emerged in the missile and nuclear weapons fields, among others. This growth in the importance of technically and mechanically skilled enlisted men has resulted in a decrease in the number of persons performing the conventional military skills. There is every reason to expect that the basic trend towards a more technical and specialized military force will continue.

I have said that about 45 per cent of our enlisted personnel requirements are in highly technical skill areas. An additional 20 per cent are in other craft and service specialities—fields which are less technical in nature. Another 20 per cent are in administrative or clerical-type functions, including supply, communications, personnel and general administrative jobs of all types. The remainder, or about 15 per cent, constitute the hard core of ground combat personnel in the Army and Marine Corps.

Under present military manpower procurement methods, the armed forces cannot acquire substantial numbers of persons already trained to meet technological requirements. This is readily understood when one realizes that about 40 per cent of all new enlisted personnel are 17 or 18 years of age at the time of their entry into service and only about 10 per cent are over 22 years of age. This suggests that a substantial proportion have not completed high school at the time of their entry into service, an assumption which is supported by the fact that

only about 55 per cent of all enlisted men presently on active duty are high school graduates. It is also apparent that many new entrants will have had little or no full-time work experience.

### Training Programs for Enlisted Men

Large scale training programs have been established by the armed forces to develop the skills needed. These programs consist of a combination of formal school training, on-the-job training, and progressive work experience. During the fiscal year ending June 30, 1957, about 250,000 persons received formal training in service schools in the technical and mechanical skills. Course lengths vary according to the skill required. In electronics the average course length is about 21 weeks; for mechanics, repairmen, and for other technical jobs, the average is about 15 weeks. Certain jobs in the U.S. Air Force require 58 weeks of basic training. Further training is also given to provide a broader technical foundation for senior, non-commissioned personnel. Although technical and maintenance skills account for less than half of the total job structure, they constitute about three-fourths of the total training load.

The complexity of weapons systems and other military equipment has not only increased the skill requirements for specific jobs, but has also made it necessary to increase the numbers of skilled and technical jobs. As a result, entrance requirements for training courses have risen, both in amount and in standard of prerequisite schooling or experience needed. For example, a great number of army training courses require background in mathematics, science or engineering; and some specify particular subjects such as algebra, physics, or electricity. It is quite likely that within the near future, a majority of the training courses within the army school system will state similiar mandatory prerequisities.

The military departments have also recognized the need for advanced education for certain of their enlisted personnel and non-commissioned officers. For example, the Navy has had an advanced school program in existence for several years. In this program, persons are sent to college for two years, after which they serve as technicians on active duty for two years. Such service is followed by another two years of college, enabling the participant to complete requirements for an engineering degree. Minimum service of two or more years after graduation is required.

Also, a program to train enlisted personnel in the sciences has just been announced by the Navy. Under this program, the four years of college will be continuous but must be followed by a minimum of four years of service. The satisfactory completion of the college portion of both these programs qualifies the participants for commissioning as officers, if otherwise acceptable.

In addition to the formal service training programs, the armed forces support a wide variety of voluntary off-duty educational programs. The United States Armed Forces Institute is the backbone of this program. Millions of servicemen have availed themselves of the opportunity afforded by USAFI to further their civilian education and to progress to better assignments in the service. This program is carried on through correspondence courses and self-teaching courses, ranging from the elementary school level through the first two years of college. At present, USAFI offers 212 courses in six major subject areas: communications, mathematics, sciences, social studies, humanities and technical-vocations. Many civilian schools grant credit toward high school diplomas or college degrees

for work taken in USAFI. During the fiscal year ending June 30, 1957, courses in mathematics and physical sciences accounted for 68,000 (or one-third) of the enrollments in USAFI courses. Other correspondence courses have also been set up with many colleges at minimum cost to the serviceman.

Another important off-duty educational program is the Tuition Assistance Program. Under its provisions, military personnel receive financial assistance in pursuing college level courses at nearby colleges or universities, or in classes established at a military installation utilizing regular faculty members of the local colleges. These courses may be used in meeting requirements for graduation.

### Shortages of Trained Enlisted Personnel

Despite our extensive training programs, our qualitative manpower resources are far from adequate to meet our needs for highly trained specialists. Only about one-third of our present enlisted force consists of career personnel who have continued on active duty beyond an initial term of service. The most serious shortages of qualified career enlisted personnel exist in the areas of technical skills.

Our problem has been turnover. Various disadvantages of military service, coupled with certain employment advantages in civilian industry have produced highly unfavorable re-enlistment rates. For example, re-enlistments for first-term regulars in the electronics field in 1957, was about 20 per cent. The comparable re-enlistment rate for all types of personnel was about 25 per cent. It will be necessary to provide additional incentives in order to retain technically trained personnel, and we are taking steps to do so. Incentives, such as pay raises, improved survivor benefits, and the like, assist in improving the situation, as shown by the fact that after the institution of such measures in 1956 and 1957, the re-enlistment rate for electronic technicians had advanced from a low 9.4 per cent in 1955, to 20 per cent in 1957.

Related to the problem of obtaining a sufficient supply of technically trained men, and of specific interest to this conference, is the problem created by the fact that many young men fail to acquire the elements of a basic education. Evidence supporting this conclusion is available in the results of the Armed Forces Qualification Test. This test consists of questions involving a knowledge of elementary English, arithmetic, and spatial relationships, among other things. Based on the test scores, each person is placed in one of five groups. Those in Group V are rejected for military service. Group IV personnel represent those who are minimally useful to the armed forces; most of them lack the general background and education required to successfully complete technical training. During 1957, about 24 per cent of all new enlistees and inductees were in the Group IV category. This certainly suggests that there is room for raising educational levels.

### Need for Specially Trained Officer Personnel

Thus far, I have dealt entirely with enlisted personnel. Officers, although constituting only about one-eighth of total active duty military personnel, furnish the combat leadership and key professional and executive ability needed to integrate our weapons and men into an effective fighting force. In general, officers do not specialize in a particular skill to the same extent that persons in the civilian economy or, in fact, in the enlisted ranks do. Basically, all officers should possess executive and leadership capabilities and a fundamental knowledge

of military science. Some degree of functional specialization is required of officers in all services, with the precise form and degree of specialization varying from service to service.

In a recent study we learned that only about 5,500 officers were assigned to research and development activities operated by the Department of Defense. This was less than 20 per cent of the total professional staff in these activities and only about one and one-half of the total number of officers in the Armed Forces. An additional 10 per cent of the total research and development staff consisted of enlisted personnel, and the remaining 70 per cent were civilian scientists, engineers, etc.

At least a college degree in science is required for officers who are assigned to professional or supervisory positions in the research and development field. The requirements for officers with a college degree and additional background in the sciences and mathematics is, however, by no means confined to the research and development field. This background is desired in many functions of the armed forces, ranging from combat units in the fleet, air wing and ground forces, to a wide range of supporting activities of a technical type. In many of these diverse activities it is impossible to draw a clear line between the types of jobs for which science or engineering training is a minimum requirement, or those for which such training is merely a desirable qualification.

The educational programs for officers furnish evidence of the importance of training in science and mathematics. The curriculums of each of the three service academies are heavily weighted with these subjects. In fact, every graduate of a military academy qualifies for and receives a B.S. degree. In addition, 35 per cent of this year's graduating ROTC classes are specializing in science and engineering. Also, certain other military educational programs, such as those at the U.S. Naval Postgraduate School, Monterey, California, and at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Dayton, Ohio, provide specialized training in these fields.

Thus, it might appear that our officer corps consists entirely of college graduates. Unfortunately, this is not the case. In fact, at the present time, only one-half of all the officers on active duty possess a college degree. Of these, about 24,000 can be considered as qualified in natural science and engineering, and about 6 per cent possess a master's or doctor's degree in the natural sciences or engineering.

Each of the military services is aware of the increasing need for formal education generated by a rapidly advancing and specialized technology. Programs exist in all services, which encourage and assist the efforts of their officers to carry their formal education to a baccalaureate, or to a higher level. These programs include regular tours of duty at civilian institutions of higher learning as well as the off-duty programs mentioned before.

As with enlisted personnel, the primary manpower problem is the retention of officers in the armed services. Large numbers of newly-commissioned officers enter the services each year. Most of them do so in fulfillment of their obligations under the Universal Military Training and Service Act, or because of their commitments to the various educational programs subsidized by the government. While many of these officers are of exceptionally high quality, the majority are not motivated for career service, and remain on duty only the minimum time required to discharge their obligations. This is especially true among those with scientific and technical backgrounds. Numerous legislative and administrative

steps have been taken to improve retention rates. Others are being considered. Most important at this time are the pay proposals recommended by the Cordiner Committee.

### Need for Specially Trained Civilian Personnel

The need of the armed forces for civilian personnel trained in science and mathematics goes far beyond the need for uniformed personnel with such qualifications. The military departments, as I have indicated before, employ large numbers of civilians in their own laboratories and in other installations. It was recently estimated that about 44,000 civilian scientists and engineers (slightly over 5 per cent of the total supply, nationwide), are employed by the Department of Defense. The federal government employs about 10 per cent of the nation's supply of such persons, and a little over one-half of these are employed by the Department of Defense.

Although government laboratories perform a considerable portion of the research and development work required by the armed forces, most of the research and development work financed by the Department of Defense, and a great preponderance of the production of military goods, including the highly complex weapons systems, is performed by nongovernmental establishments. It is extremely difficult to arrive at reliable estimates of the scientific and technical manpower involved in work performed for the government by contractors. It is generally agreed, however, that the programs of research and development financed by the federal government are one of the major factors contributing to the tremendous increase in recent demands for technological manpower. It has been estimated that federal research and development projects account for about one-third of the total employment of scientists and engineers. The Department of Defense, and the Atomic Energy Commission account for over 80 per cent of these federally-supported programs. It is not anticipated that there will be any curtailment of Defense Department expenditures for research and development in the future. In fact, recent actions by the executive and legislative branches of the government point to further expansion of such programs.

The increase in the number of federal research and development programs and other defense programs, plus demands induced by nondefense needs have created a shortage of scientific and engineering manpower despite remarkable increases in the supply of such personnel during recent years. We are on the threshold of a technological revolution in which each new scientific breakthrough generates additional requirements for personnel in order to exploit all applications of basic scientific knowledge. The National Science Foundation has predicted that twice the present number of scientists and engineers will be needed by 1970.

Not only are there shortages of professional scientists and engineers, but supporting technical personnel, generally called technicians, are also in short supply. I have already dwelt on the problem in regard to our enlisted personnel. A great part of that problem is caused by the over-all shortage of such persons in the civil economy. Also, this shortage aggravates and intensifies the problem of attempting to meet the demands for professional workers since the latter must perforce perform many routine duties which technicians normally would handle. The professional worker and the technician form a team in which the former plans and creates, while the latter carries out and applies such plans.

According to a special Working Committee of the President's Committee on Scientists and Engineers, this country is graduating less than one-sixth of the

required number of highly skilled scientific and engineering technicians, through accredited or approved courses. These courses, which generally must be studied for a two-year period, are given in technical institutes, junior colleges, extension divisions of colleges and universities, proprietary schools operated by individuals or corporations, industrial schools and the like. Technicians are also being developed among existing trade and craft personnel through special training courses; although, according to the Working Committee, this source provides neither the quantity nor the quality of technicians needed.

The ratio of technicians to professional scientists and engineers is considered inadequate at present; and since sharp increases in the numbers of professional graduates are predicted for the future, those persons and groups concerned with attaining an adequate supply of technological manpower should give special attention to the urgent need for improving our resources of technicians. It is quite evident that this is one of the really weak spots in our present educational system.

## Conclusion

I have attempted to indicate in a rather broad way the need of the armed forces for persons with technological training. I have shown that the need exists not only for such persons in uniform but also, and to a larger extent, for persons in the civilian economy, both those in the employ of the Department of Defense, and those in the employ of contractors. The need is increasing progressively as the weapons of security become more and more complex. At the same time, the needs of our society in general for persons with such training are also increasing rapidly as we enter a new technological age.

At the present time, the needs of the armed forces, as well as the total needs of the country, are not being met satisfactorily. The supply of qualified technological manpower must be increased if the security of our nation is to be assured, and the full potential of a scientific age is to be realized.

The problem of meeting our technological manpower requirements must be approached from a number of angles, by various groups. It cannot be solved merely by getting increased numbers of our qualified youth to pursue careers in these fields, although admittedly that is one of the desired objectives. It is more important to take positive steps to insure that the *quality* of our technological manpower is improved.

We in the Department of Defense are impressed by the emphasis currently being voiced by more knowledgeable persons and groups in the educational field as to the desirability for taking action along such lines as increasing and enriching secondary school instruction in science and mathematics. A concomitant to this approach to the solution of the problem is the need to improve the economic and social status of our teachers so that more qualified persons will be attracted to the profession. This country's apathy toward its teachers, who are absolutely essential to the attainment of higher educational standards in general, and the improvement of the quality of our technological manpower in particular, is nothing short of a national disgrace.

We are aware that many constructive efforts are being carried forward in responsible educational circles to make many of the necessary improvements. We are also aware of the many co-operative efforts which industry is making in this direction. We certainly hope these efforts will be intensified and that they will enjoy the fullest measure of success.

We are also hopeful that an awakened public understanding will lead to solutions of the serious problems facing the schools. Of course, you know the problems far better than we do. I would add only that continued progress in meeting all these educational needs is fundamentally important to our national security. That is a point we always emphasize in our meetings with various national organizations such as defense-supporting industries, and other important groups.

In this connection, you will be interested in knowing that the Department of Defense is supporting the "Educational Development Act of 1958" recently introduced in the Congress by Senator Smith of New Jersey and Congressman Kearns of Pennsylvania. It is our opinion that enactment of this bill would contribute substantially toward the alleviation of our specialized manpower shortages.

This conference on the educational situation in California is extremely timely and worthwhile. I hope it will produce positive, constructive results and that other states will see fit to follow its example, as a means of solving one of America's gravest problems.

# THE NATION'S MANPOWER NEEDS: A CHALLENGE TO EDUCATION

**ARYNESS JOY WICKENS,** ***Deputy Assistant Secretary of Labor, United States Department of Labor***

I am honored to be invited to represent the United States Department of Labor at this state-wide discussion of the teaching of mathematics and science. This is a very popular conference subject these days. Early this month, a very inspiring and effective national conference, with the theme "America's Human Resources to Meet the Scientific Challenge," was held at Yale University, under the auspices of the President's Committee on Scientists and Engineers; and was attended by some 300 interested citizens, including leading scientists and educators, representatives of business, the press, radio, television, and government. For two days they discussed ways and means to meet this challenge. Constructive suggestions were made, affecting all levels of education and there was some very plain talking. The papers from this conference merit your attention.

Several points of emphasis at this conference struck me with considerable force. It was generally agreed that mathematics and science are not subjects to be set apart or to be presented at the expense of other essential subjects. Rather, it was the view of the conference that mathematics and science have always been and should continue to be regarded as part of a sound liberal education. As James R. Killian, Jr., President of the Massachusetts Institute of Technology, and Presidential Special Assistant for Science and Technology, said, "It is my own deep conviction that the liberal arts cannot be liberal without including science, and that humanism is an indispensable ally of science in a sound scientific education." Dr. Killian also expressed the view that we have not given a sufficiently high priority to mathematics and science in our educational system, and that the need is to strengthen and modernize science education so as to raise it to the level of the pace-setting teaching in the humanities. Lee A. Du Bridge, President of the California Institute of Technology, put it quite succinctly when he said: "it might be well to introduce the age of science into our school system."

In an effort to raise the level of our national attainments in science and engineering, great stress was placed on the understanding of science and mathematics by the public in general. The citizen of tomorrow—who is the student of today—will need a high degree of scientific literacy, even if he is not engaged professionally in engineering or in one of the sciences. Without the vocabulary of science and some acquaintance with the scientific method; without knowledge of mathematical symbols and processes, the citizen will not be able to read magazines and newspapers intelligently or understand issues of importance in the space age.

There was general agreement at the Yale conference that if we are "to do something about it", state and local action will be required—action by thousands of schools, thousands of school boards, thousands of parent-teacher associations and college boards of trustees. In our democracy with its vast network of public schools, public understanding and public determination to take action are essential before major changes in the curriculum or in attitudes towards science and mathematics can be achieved. A meeting such as this one today, representing educators,

business and industry, government, and the public, can therefore have great significance for the future.

There can be no question of the seriousness of the situation. It is not merely an academic matter, and we cannot be too leisurely about it. Fortunately, the nation has suddenly come to realize the fantastic danger to our ultimate military strength and to our economic position in losing the international competition in science. The key to this race is people—human resources—those who will be available during the next two decades. We know their numbers. We know a good deal about how the older ones have been educated and what they are doing. We know too that how they use their talents will determine who wins this scientific competition, and that in a democracy performance depends upon the free decisions of millions of individuals.

As a background for the deliberations of this conference, I have been asked to discuss manpower in relation to the future occupational needs of the nation, and to indicate the challenge which this presents to education.

First, let us consider the supply side of the manpower picture for the nation as a whole. We have over 70 million people in our labor force, including the armed services. It is estimated that as the population expands, the nation will need a net addition of about 10 million workers over the next decade. All of these persons are already a part of the population. But who are they? Young people under 25 will comprise about one-half of the net increase in the labor force between 1955 and 1965; the other half will be comprised of people over 45. Of the increase of 10 million workers, half will be women. Because of the low birth rate of the 1930's, there will actually be about 700,000 fewer young men (25 to 34) in the labor force in 1965 than there were in 1955. But in California, you may have more people in their young working years in 1965, contrary to the trend for the rest of the country, because your population is increasing at more than twice the rate of the rest of the country, especially among younger people. Therefore, you will not have the problem of absolute shortage, although your industrialists tell me that they too are in need of more highly educated and highly trained and skilled people.

For the nation as a whole, the low birth rate of the 1930's has meant that inadequate numbers of young people have been available in the face of exceptional increases in demand. Thus, the low birth rate of the depression years has become a very important factor in the shortages of certain types of employees. This situation has prevailed during the 1950's, and will continue for several years. Remember that today's college freshmen were born in 1939, and that the birth rate did not increase materially until 1941 and 1942. Thus in meeting the nation's need for scientific personnel in the immediate future, we must look to the comparatively limited number of young people now in college and high school age groups, and concentrate on improving the level of their education. The principal other sources of additional workers will be older workers who remain longer at work, or women coming into the labor market in increasing numbers. This implies that to insure the necessary number of highly trained employees, industry will have to make every effort toward better utilization and retraining of its existing staff—perhaps with assistance from the educational system through more widespread courses of adult education.

As we look ahead to the mid-1960's and beyond, we see that there will be a tremendous increase in the number of young people available for employment. Consider the number becoming 18 years of age—the age at which all requirements

with respect to school attendance end in California, and the age at which many young people go to work or into the armed forces while others go on to college. The first big increase in 18-year-olds comes in 1961 when today's high school freshmen, born in 1943, will be 18. Then the number of 18-year-olds declines, and the next very large increase does not come until about 1965, when today's sixth graders, born in 1947, will be 18. There will be a total of 4 million 18-year-olds in 1965—an increase of one million during a two-year period. Reinforcing this wave of high school graduates will be the large group of college graduates (today's high school freshmen), who will be 22 years old. In 1965, the total of 7 million young people available for employment will comprise 4 million 18-year-olds and 3 million 22-year-olds. Thus after a period of short supply we will have a period of comparatively greatly increased supply. Educators are, of course, familiar with this timetable because they can count the number of youngsters in school today. From the point of view of the nation's needs for manpower, the major requirements to be filled include sound basic education, good vocational guidance, careful selection of talent, and, in general, the motivation of young people to seek an increasingly high level of education to fit them for their future life's work.

That is the supply side of the picture. Now I want to turn to the demand side and summarize anticipated manpower requirements for the nation as a whole, by occupation and by industry, and analyze the additional preparation that these requirements necessitate.

The occupational requirements of the nation will continue to shift toward jobs that call for more education, a better quality of education, and more mathematics and more science. The focal point of our occupational structure is shifting away from brawn toward brains.

The major changes appear to be a long-term rapid growth of the white-collar group of occupations; a slower growth in the blue-collar occupations, accompanied by a continuing rise in the level of skills required; a sharp decline in employment among farmers and farm laborers; and a faster than average growth among service workers. In 1956, for the first time, white-collar workers (professional and technical workers, managers, officials and proprietors, clerical, and sales workers) exceeded the number of blue-collar workers (craftsmen, operatives, and laborers).

The industrial composition of the working population is also shifting. Perhaps the most obvious change has been the shift from agricultural to nonfarm work, and this is expected to continue. Among the nonagricultural industries, employment has increased most rapidly in trade, finance, service, construction and government; and has declined in mining and transportation. Manufacturing employment has been increasing at a rate somewhat less than total nonagricultural employment. The major shift within manufacturing has been from the nondurable to the durable goods industries. In the future, we expect that the largest employment increases will take place among the metal working industries.

As we look ahead to the mid-1960's, the labor market for all the traditional major occupational groups is expected to increase except for common labor, which is expected to remain static at about 3.7 million; and for farmers and farm laborers, for which demand is expected to decline by as much as 15 per cent, or about one million. These developments represent a continuation of trends that have gone on over several decades and have been especially pronounced since the end of World War II. In agriculture, the application of scientific discoveries, and growing mechanization have increased output per man-hour more rapidly than in almost any part of the American economy so that today our farms are pro-

ducing more food and fibers than ever before with about the same number of agricultural workers as in 1870.

The fastest growing occupational group is that of professional and technical workers. By 1965, it is anticipated that the nation's requirements for professional and technical personnel will be over 40 per cent greater than they were in 1955—a per cent increase two and one-half times as great as that of the labor force as a whole. A very much enlarged corps of technical aides, and more skilled workers will also be needed to support the professions, to produce and maintain the machines of the new technology, and to build plants and equipment. The demand for skilled workers is expected to increase nearly 20 per cent in 10 years.

The next most rapidly growing group is in sales and clerical occupations, accompanying the rise of trade, finance, and service industries, and the employment of more white-collar employees in manufacturing and other basic industries.

The demand for semi-skilled workers, where automation, new processes, and new labor-saving devices are currently having the greatest effect, will also increase, but by a somewhat smaller per cent than that of the demand for skilled workers.

Proprietors and managers are expected also to increase in numbers, but at a slower rate than the increase in either professional or skilled workers.

Because of their growing importance, let us take a closer look at the anticipated future demand for professional and technical workers. Within this group, the employment of scientists and engineers, now estimated at about one million, has increased at a much faster rate than employment in the traditional fields of medicine, law, teaching, and the ministry, especially since World War II. In the future, the demand for scientists and mathematicians, especially for those with high talent, is described by leading scientists and educators as virtually unlimited. So rapidly is the demand for scientists and engineers growing that double the present number of engineers may be employed by 1970.

As all of you present at this conference well know, the need for teachers, in most disciplines and at all levels, is desperate now and will accelerate every year for many years to come. Turnover alone requires the replacement of around 10 per cent a year, in addition to the staffing of new classrooms. In virtually all branches of medical service there are present shortages and they will continue. The public's requirements for medical care are likely to build demand for personnel faster than medical and dental schools can supply graduates.

The law and the ministry will also require more members as population grows, but it is anticipated that membership in these professions will increase at a somewhat less rapid rate. There will also be an increase of members in the newer professions—accounting, statistics, dietetics, library work, and social work.

Since the number of young people now enrolled in professional schools is, practically speaking, limited, it becomes all the more urgent to give special attention to the training of mathematicians and technical aides to permit more effective utilization of experienced professional workers. I refer to medical and dental technicians, nurses aides, draftsmen, electronic specialists, and others—all now in short supply and all in great demand. Generally speaking, the American educational system is not organized for this type of training, much of which is done in the armed services and in industry. In Russia, the situation is quite different. There, in their flourishing "technicums", they have trained an average of over 67,000 engineering technicians each year, from 1946 to 1950, while in 1955-56, our American technical institutes, junior colleges, and other institutions of higher education produced about 12,000 scientific and engineering technicians. A survey

of the nation's needs and facilities in these fields is now under way. The importance of technical aides is being given great emphasis by the President's Committee on Scientists and Engineers. Here in California, where, I understand, you have a large per cent of the junior college enrollment of the country, there are opportunities for greater use of existing facilities to meet the rapidly growing need for technicians with two years of specialized training.

For skilled workers—craftsmen, foremen, and similar employees—the growth in demand is expected to amount to about one and one-half million during the 10 years from 1955 to 1965. There will be especially great need for building trades craftsmen and skilled maintenance and repair men who can build, install, maintain, and repair complicated machinery and equipment. Aside from the construction industry, another source of the demand for skilled workers will be the metal working industries, including those that produce machinery, missiles, aircraft, and fabricated metal products.

The demand for semi-skilled workers such as single machine operators, assembly line workers, and truck drivers will also increase. In these fields the new automatic and semi-automatic machines are having considerable effect. However, the effects of automation should not be overestimated. A substantial increase of about 1.7 million semi-skilled workers by 1965, is the current estimate.

The anticipated increase in demand for clerical and sales workers has already been referred to. It will come from all industries, and will be a source of employment for people everywhere in the country. There are considerable shortages of personnel in some of these occupations today. Jobs in the clerical and sales fields are increasingly filled by women; and more often than other jobs, are filled by part-time workers. This area is also one which merits continued close attention.

Little has yet been said about the service occupations. In this category we always think first of domestic servants, janitors, laundresses, elevator operators, and the like, but we should remember that this group also includes such expanding service occupation workers as policemen, waiters and waitresses, practical nurses, and beauty shop operators. This group of workers has been growing rapidly, and is expected to increase from a little over 7 million in 1955 to 8.7 million in 1965.

I cite the anticipated growth in all of these occupational groups to emphasize the fact that it takes all kinds of work to make this country's economy operate. All of these jobs are essential and important. Just because attention today is dramatically focused on the scientists, mathematicians, engineers and astrophysicists who can conquer outer space, it does not follow that the earth-bound pursuits are losing their essentiality, their interest, or their dignity. There are all kinds of people at all levels of ability at work and in the schools. We must educate them and train them to find the occupations for which they are individually best suited.

Most of the expanding fields of work require a higher level of education than was considered necessary a generation ago. To be sure, most of our people are getting more education than formerly. Nationwide, about 64 per cent of the population, 17 years of age and over, complete high school; in California, the proportion is higher. We sometimes forget that as recently as 1930, less than 30 per cent of the population completed high school. A high school education is becoming virtually a minimum requirement for clerical occupations, for many skilled trades, and for many other occupations as well. In the future, it will be increasingly difficult for anyone without a high school education to obtain a job that requires technical skill or responsibility.

The standards of education for the professions are continuing to rise as more and more technical knowledge, and newer and more complex developments must be covered in the curriculum. The contrast with standards of even a generation ago is great. In medicine, for example, six years of college and another year of internship were then considered good preparation; now eight years of study beyond high school are necessary, and ten years or more are required in certain fields of specialization. More graduate work is also demanded for teachers, scientists, lawyers and clergymen.

Today a great many occupations—and they are increasing in number—require education in mathematics and science. Among the 500 occupations described in the current edition of the *Occupational Outlook Handbook*,[1] we find many which require mathematics at the college level. Among the professional occupations that require such study, in addition to engineering and the sciences, are medicine and dentistry, dietetics, psychology, and economics, to cite only a few examples. In many types of businesses, such as modern large scale accounting and statistical systems, knowledge of mathematics and study in the sciences is required for an understanding of a great variety of industrial processes and products. Salesmen as well as production men find such knowledge useful.

High school or vocational school instruction in mathematics is basic for such occupations as bookkeeping, statistical work and many clerical jobs; and in the skilled trades, for electronics, airplane mechanics, instrument making, and sheet metal work, to name only a few.

In order to make clear the universal need for mathematics, the U. S. Department of Labor, in accordance with suggestions made at a recent conference on education and employment held by James P. Mitchell, Secretary of Labor, has prepared a list of occupations for which mathematics is important. This is in the process of publication. It will be available to all of you who teach mathematics or to those who need such a list to help impress upon young people the importance of the study of mathematics.

Parents as well as students need to understand that failure to learn mathematics and science in high school may literally close the door to many occupations. The high school students of today will not only be the new recruits for industry in the 1960's, but they will be at work for the next 30 or 40 years of their lives. To be able to do the jobs of tomorrow—some of them undreamed of today—they will need every bit of solid preparation they can cram into four years, in English and the languages, in mathematics and science, in history, in civics, and in other liberal arts preparatory courses. One of the very real problems in education is how to make both parents and students aware not only of this fact, but of the other occupational facts of life. I submit that it will take all of our best efforts, working not only through the school systems, but also through public service organizations, industry, the press, radio, and television to accomplish this.

To me, one essential service is a sound system of vocational guidance in the schools. Vocational guidance is no educational frill. It is the key to proper education for the students of today so that they may hold jobs with a future, and so that each individual student may be trained in the kind of work for which he or she is best fitted.

To give background information for this task, the U. S. Department of Labor has prepared a considerable number of publications for the use of vocational

[1] *Occupational Outlook Handbook: Employment information on major occupations for use in guidance.* Bureau of Labor Statistics Bulletin No. 1215. Washington, D. C.: U. S. Department of Labor in co-operation with the Veterans Administration, 1957.

guidance counselors and employment counselors in state employment services. Many of these publications are on display here today. They include the 1957 edition of the *Occupational Outlook Handbook*, which covers 500 occupations; and a periodical, the *Occupational Outlook*,[2] issued four times during the school year to supplement the handbook. Reprints of certain chapters in the handbook, dealing with different fields of work, are also available. The U. S. Bureau of Labor Statistics, which prepares these publications, also issues wall charts on particular occupations of current interest; and summaries of new occupational outlook publications.

The Women's Bureau of the U. S. Department of Labor publishes a series of bulletins of interest to girls and young women, such as *Is Math in the Stars for You?*[3]

The publications of the Department are designed for use not only by counselors but also by senior high school students, veterans, teachers, and others interested in career information. In general, they are not designed for use by junior high or elementary school students. It has been suggested that the Department issue a junior edition of the *Occupational Outlook Handbook* for the use of junior high school students; and that it prepare other popularized versions of publications on various occupations, to attract the attention of students. While I am here, I should appreciate your advice on these matters.

In California, you are fortunate in having some fine, specialized tools for vocational guidance. The California State Departments of Education and of Employment have issued brief occupational guides for over 100 occupations, localized for the Los Angeles-Long Beach area, the San Francisco Bay area, and for the Sacramento-San Joaquin area. They include information on the California industries which employ workers in each of the type of occupations outlined.

Choosing the occupation for which a person has ability and interest is just as important as sound education. The nation is not well served, nor are individuals, by frustrated engineers who should have been dairy farmers, or actors, or accountants. No group appreciates the importance of good job selection more than does industry. Good job guidance should have as its basis a sound program of testing and counseling in the schools; it should sort out the outstanding, talented youngsters who may be potential scientists and mathematicians; and it should also identify boys with mechanical ability, or girls with high clerical aptitude, and weed out those individuals who are not suited for certain types of occupations.

Here again, California schools are using a variety of tests, both aptitude and educational. From the point of view of our manpower needs, particular attention should be paid to the General Aptitude Test Battery, developed by the U. S. Employment Service, and validated for 23 occupational groups, including 600 occupations. It has been released by the California State Department of Employment to a number of California schools, and is also being administered to seniors in a number of California high schools, by local employment service offices.

Vocational education is the key to building skills in those areas where numbers of better trained and better educated people are most needed. Vocational training for agriculture, for crafts, for clerical skills, for the newer processes in electronics,

[2] *Occupational Outlook: A Current Supplement to the Occupational Outlook Handbook.* Bureau of Labor Statistics. Washington, D. C.: U. S. Department of Labor, in co-operation with the Veterans Administration.

[3] *Is Math in the Stars for You?* Leaflet 28. Washington, D. C.: Women's Bureau, U. S. Department of Labor, 1957.

and for providing related education for apprentices in training have been especially valuable. Modern vocational education for many young people whose skills are in these fields, may well be the answer to many of our manpower problems.

The technology of tomorrow will require all kinds of occupations—many thousands of them. Our young people cannot all be scientists or engineers; indeed, only a small proportion of them are needed in these professions. Lest we become "technical snobs", let us remember that the nation's greatness rests on the work of all of its citizens doing the best they can and contributing according to their ability.

The school system is now doing a terrific job under handicaps that have accumulated over a period of years. It will take the full understanding and support of the public and of industry to enable the schools to meet the growing challenge of educating young people for the jobs of the future.

# SCIENCE AND MATHEMATICS EDUCATION AS VIEWED BY A CALIFORNIA BUSINESS EXECUTIVE

**H. L. HOFFMAN,** ***President, Hoffman Electronics Corporation, Los Angeles***

It is a pleasure and a privilege to talk to you today on the subject of science and mathematics education. This is a subject that affects all of our lives but has a particularly strong influence in our business. I have had the pleasure of attending some of the sessions this morning. You certainly have been well briefed on the need for expanding and improving our scientific training in both the secondary and college educational processes, and you have and will be exposed to a great many statistics on this subject.

It may well be that 1957 will go into the history books as the year in which we recognized that scientific research is the newest and most dynamic force affecting industry and one that is rapidly changing the face of the earth. It was the year of the missile, the year of the satellite, and the International Geophysical Year.

It was a year of increased theoretical exploration of matter and the universe, of higher-strength and higher-temperature metals, of drugs for mental illness, of nuclear knowledge becoming public property, of jet transports, of more powerful radar, of new frontiers established on data-processing, and of undreamed-of new materials.

In the United States, spending on research of all kinds skyrocketed from less than 1 billion dollars a year before World War II to 10 billion during 1957. Research sponsored by industry more than doubled between 1953 and 1957. Industrial research alone topped the 7 billion dollar mark during the past year.

Here in California we have seen this explosive growth sparked by technological developments as well as by the applied engineering that follows a scientific breakthrough.

At the outset I should tell you that I am not an engineer by training, and it would be presumptuous of me to advise this group of experts on the fine details of engineering education. Rather, I would like to take the position of one who has rubbed elbows with hundreds of your graduates over the past decade and a half and who, as a result, has some observations to report on the end products of our educational system.

Our company employs some 3,000 people. Of these, one out of every four has at least two years of formal technical training or its equivalent in experience. The velocity of technical developments indicates that this ratio will grow to one out of three in the next three years, and ultimately one out of two. Recognizing this inevitable trend, our company spent almost $2,000,000 last year to expand and modernize its facilities for applied research and technical development.

Our company started in Los Angeles some 16 years ago with three people. One of our original concepts was that a California organization must have a higher ratio of creative thinking in its products or services if it is to market them successfully either in the West or on a national basis.

I have had the exciting experience of participating in the growth of the electronics industry here on the West Coast and observing its impact on our economic and social structure. It has grown from approximately 20 companies doing a

volume of business of approximately $40,000,000 a year before World War II to something less than 1,000 companies doing more than $1,500,000,000 in 1957. The electronics industry has become the second largest employer in the southern California area.

The significant fact of this growth is that most of the work in which we are engaged today is concerned with ideas, products, and services that were not known or even thought of before the war, and most of this dramatic growth has come about within the past seven years. Significantly, most of us feel that we have just started and that we are on the threshold of an even greater horizon providing we can secure from our educational processes competent men to take advantage of these tremendous opportunities.

Since the profit and loss statement of our company is so strongly influenced for better or for worse by the technical competency of our engineers and scientists, I am obliged to be quite objective, and I might even say critical, of the performance of our technical personnel. I consider them as members of the team with the same responsibilities and obligations to their company and to society generally as any other citizen and employee. If we accept this premise, then we must abandon the concept that the engineer or the scientist is some kind of odd ball to be pampered and treated as a member of a class apart. We must, over the long haul, judge him, and the engineer must be willing to be judged, in a manner established by his contributions to society as a professional man and as a citizen.

Consequently, there are really two areas of education facing the scientist and the engineer—his preparation for his professional life and his preparation as a citizen. The second of these, while no less important, is beyond the scope of my remarks today, so I will confine myself to the first area and, again, to my observations that I believe are typical of industry and the unique conditions I have previously described.

Mr. Khrushchev, in his anxiety to achieve a propaganda scoop, violated the agreements of the I.G.Y. officials and launched the Sputnik prematurely. He accomplished the scoop, but I wonder if he realized the side effects of his actions. Actually he focused tremendous national attention on our educational system—something I know you people welcome. Out of it I am sure much good will come. Good for us; not good for Mr. Krushchev.

It is characteristic of the democratic processes that our deficiencies must be dramatized in order to focus attention upon them and get something done. However, I think as a nation we are talking ourselves into a severe inferiority complex; we are inclined to discount everything that has been done and to interpret all of our processes as faulty. Certainly we need a complete appraisal. Our educational system has become suspect, and I think this is great fortune because, Sputnik or no Sputnik, we know that we must push on in science and technology if we are to survive. Ours is the highest standard of living in the world and we cannot contemplate any retrogression of this standard, but we cannot simply maintain the status quo. Civilizations do not stand still; either they move forward or they move backward.

To move forward in this increasingly technical world, it is obvious that we need more and better scientists and engineers. On this point I think we have almost universal agreement. The question is: How do we win this objective? We have learned in our business that if we want a good appraisal we examine the product. This, I grant, is a much simpler job than appraising the products of our schools with due regard for the human ingredients.

Generalizing is a dangerous indulgence; therefore I express these thoughts as general feelings based on my own observations and discussions with many of our people who have in their lifetime worked with several generations of scientific and engineering graduates.

First of all, I think we can safely say that our scientific and technical educational system has definitely moved ahead over the years. Graduates today are noticeably better trained academically than their forebears. However, this comparison, although favorable, does not measure up to the job that we need to do. To analyze this matter specifically, I would like to break my observations down to (1) the technical competence of our human product; and (2) his personal competence.

First, the per cent of graduates with creative ability is lower than that of graduates without such ability. Our present product seems to lack the kind of training in basic fundamentals of science that is good enough and thorough enough so that when he faces a problem he can build a solution from the ground floor instead of trying to find it in a handbook. He also has great difficulty in coordinating his thoughts to move toward a definite objective.

I might comment that many of us feel that scientific education should start sooner in the secondary schools, and deal more intensively with basic fundamentals at a sacrifice to some of the elective subjects that dilute the time and energy of the student. Our European scholastic competition follows this pattern.

We have found that if a graduate is well grounded scientifically, he becomes oriented from a product-engineering viewpoint more quickly and his scope becomes broader.

We have also noticed a great lack of uniformity of quality; this does not mean that the graduates of certain schools are all good or all bad. There is simply very little standardization. We also notice that there is little uniformity in standards of requirements, and this becomes more noticeable as the educational processes unfold.

We also find that many of our textbooks are outdated in so far as current knowledge of basic developments is concerned.

Many times our human product lacks the capability of organizing his facts towards the decision-making process. This is a by-product of how well he was educated to study and to organize his facts. In too many cases our product today has become a conformist in his mental processes. We need men who will have the mental courage to depart from the status quo.

One of our great problems with our human product is the very simple element of communication. There was a time when I felt somewhat deficient because I could not understand our engineers. However, after recognizing that they couldn't even understand each other, and specifically when the subject was technical, I realized that this was one of the areas where our educational processes, both in college and out of college, had broken down. Many good ideas are completely lost because of the lack of ability to express them. It appears to me that our educational processes should give this problem of communication a serious look and do something about it. I personally believe that a public speaking course is a great benefit to an engineer as well as to a business major. Much of our time and effort these days is spent working out proposals and presenting ideas at engineering symposiums. This is one of the ways that recognition is achieved by a scientist. Too high a per cent of our present-day scientists and engineers find it difficult to express themselves properly.

When I speak of personal competence, I am concerned over the attitude of mind on the part of our educational product. Too many graduates seem to lack the curiosity or appetite for finding out facts. And too many of our engineers are overly concerned with fringe benefits, job security, and other overrated by-products of our age of competition.

Many persons feel that industry, because of the great demand for scientific and engineering graduates, has erred in overemphasizing fringe benefits in its competitive bidding for graduates. I think that any of us who do overemphasize in this way work a great injustice on the college men we hire. I firmly believe that the happy engineer is that individual who can lose himself in his job and can experience the keen satisfaction of mastering a tough problem for itself rather than for any other recognition.

It seems to me that our young people have lost a great deal of ground because of their lackadaisical attitude toward hard work and personal accomplishment. Too many of them seem to have the attitude that they should work as little as possible, avoid as much risk as possible, and be on hand at the coffee break! Possibly we in industry and possibly you in education have failed them by not insisting upon a stricter discipline and not teaching more of the homely virtues and the satisfactions of doing a good job. If we have, we should correct our mistakes and take the steps to avoid making similar mistakes in the future.

The engineering problem is broken down into two segments. Its solution depends first, upon improving the quality of the training that engineering graduates possess and secondly, upon increasing the quantity of graduates produced.

There is one very important reason for having an increasing number of high school graduates enroll for engineering and science programs. If a sufficient number of high school graduates seek such training, we can be highly selective in our acceptance at the college level and thereby make sure that a large per cent of those completing the four-year program would be good material for advanced degrees. Our reason then becomes one of getting high quality results in sufficient amounts to meet our needs.

Another factor regarding our educational system that has always caught my eye is that to my knowledge we have no means of adequately meeting the needs of exceptionally brilliant students. Conversely, we do have, I am told, special schools for juvenile delinquents. Our attention seems to have been directed more to bringing the problem child up to average than to giving the above-average student special consideration. Society needs exceptional minds.

Summing up my comments, I would say that my look at science and mathematics in our educational institutions indicates that the programs in these areas of instruction have steadily improved and are considerably better than they were five and ten years ago. However, the rate of improvement has not been sufficiently great if we are to continue competing in the world markets with our products and to remain strong as a nation.

Such meetings as the one we are now attending are only as beneficial as the constructive action they generate. I have only touched on the fringes of a few of the problems involved in our educational process. I might add that I have great respect for you people in the educational world and the services you render to society. The work you are doing merits the support of all. I feel that the handwriting on the wall makes it clear that you will get more support in the future, and this support, in turn, will enable you to step up to the gigantic job ahead with enthusiasm and confidence.

# SCIENCE AND MATHEMATICS IN THE ELEMENTARY SCHOOL

**HAROLD SPEARS, *Superintendent, San Francisco Unified School District***

The school superintendent today finds himself somewhere in outer space as he tries to determine his location and get his educational bearings. He sees Sputnik on one side, and his position has even shifted a little since Explorer I went up. He has the budget on another side, and while he tries to keep an eye on that, other significant matters come within his orbit.

The matter of knowing what the school program should be today and how much it should cost is not simple, and naturally this conference is going to get into both aspects of it. Here we cannot separate one from the other any more than a superintendent and his board of education working with a budget could do so.

I would rather have had you people this afternoon visit an elementary school with me to see science in operation. To listen to a brief talk on this topic is a poor substitute for visiting schools. I think perhaps we have a false conception about children today. I hope this conference doesn't have the conception that the adults have to do something in a hurry to introduce science to the child of young age. That child is ahead of us. He's pulling at our coat tails to get us to recognize his interest in science, and all we need to do is take the cue and move on through with him.

The child used to bring butterflies to school and bats and other things and try to get the teacher to develop something around his contributions and to explain them. But he's not satisfied with that today. He brings in pictures of satellites and the like. The bats and the butterflies are a little too slow. I'm going to bring to your attention a few of the things that elementary children in San Francisco are doing in science, and I think these are typical of the school systems over the State of California.

Kenneth, age seven, wrote these things the other day in his spelling lesson. I will admit his lesson was just a little longer than the typical child's spelling lesson. He had these words in his second grade assignment: *more, tall, pet, clean, community, helps,* and *jumped.* In his first sentence he used the word *more,* and this was his statement: "We need more ICBMs and IRBMs because Russia is ahead of us in military equipment." He satisfied the teacher's requirement that he use the word *more* in a sentence, and he also satisfied his own ideas about what he wanted to talk about. I'll just rapidly go through his paper.

The second word was *tall.* "We are developing a super-transport with a tail as tall as a three-story building." The third sentence had the word *pet.* "The first Russian satellite to be sent up was called 'Sputnik I'; the second satellite had a pet dog in it." Fourth: "Technicians clean ICBMs because they want everything to be right inside the ICBM." Fifth: "In the community there are many all-weather interceptors stations." Sixth: "The Navy helps the Army in putting the IRBM into production." Seventh: "The Russians sent up a satellite with a man in it. The man inside the satellite jumped out with a parachute on." This was January 9, before our Explorer went into orbit, when Kenneth was writing these things and perhaps he didn't have all of his facts right. Kenneth, of course, is not typical of the second-grade elementary child who is doing science. I would say

that this next one I will read to you perhaps typifies the average child, at least in the particular school I'm talking about.

This youngster wrote about the microscope. Here you have a report in which a boy is writing very factually about the things he and the other children are studying in his classroom. He said: "A microscope is an instrument that scientists use. When you look into a microscope you can see things that ordinarily are hard to see. It depends on how powerful your microscope is what you will see. Some microscopes are big and some are small." That was Joe's paper.

In the same class we have another one or two. This is a girl's paper: "The fuse. There is not only one kind of fuse; there are two kinds. One kind is a small one and has glass. The other is small too, but it does not have glass. They both have thin metal in them. It works like a bridge. Electricity passes over it. If my mother overloads the wire, the fuses will go out. That means the bridge melts so electricity cannot pass. If you did not have any fuses in your house and you overloaded the wire, your house would catch on fire." Those are Wendy's observations.

Now, if we can believe the statistics, Wendy will use science up to a certain point in her life and then she'll drop it like a hot potato. In 1955 in this country 22,589 people got their A.B. degrees in engineering. Of this number only 62 were women. Of the 4,678 that got their master's degrees in that field, 14 were women; and of the 599 that got their doctoral degrees in it, none were women. We'll do our best with the girls up through elementary school in this field of science and they'll move right along with the boys. But whether our society should prepare American women for engineering and use their services as engineers in order to compete with the country that does use women in this field is for our society to decide. We educators can do very little about that.

Here in California the Education Code (Section 10302) has this to say about the elementary school curriculum: "The course of study in the elementary schools shall include instruction in the following prescribed branches in the several grades in which each is required pursuant to this article: (a) reading, (b) writing, (c) spelling, (d) language study, (e) arithmetic, (f) geography, (g) history of the United States and of California, (h) civics including a study of the Declaration of Independence and of the Constitution of the United States, (i) music, (j) art, (k) training for healthful living, (*l*) morals and manners, and such other studies not to exceed three as may be prescribed by the board of education. . . ."

Science is not in that list. But the State of California has furnished science textbooks for many years. We have a good State series of science books, and I think that schools are generally including science in their work. But in an elementary school, where you have a crowded curriculum and you are teaching many subjects, science does always come as a set period in the school day, and this fact, I think, is borne out in Kenneth's and Wendy's papers. Science crops up in language work. It crops up in social studies, in spelling, and in other areas. And sharp teachers make use of scientific ideas whenever they do appear in the children's work. Sometimes we criticize the field of education for the efforts that are made to teach teachers methods. But if you did not teach methodology to elementary school teachers, they couldn't handle the long lists of subjects to be explored by children in the classroom and handle them in the masterful way that good teachers do.

In San Francisco ten years ago we developed a series of science guides for teachers. As the materials in your packet indicate, you will find that these guides

are all over the state and that reference is made to the number of guides that are in use. These science guides were developed by 150 teachers working with four other teachers who spent a year and a half as leaders of the project. One guide covers kindergarten through second grade. There is one for third and fourth grades and one for fifth and sixth grades. The guides are all developed around concepts of science. We didn't try to grade the work in these guides according to what children should have in kindergarten or in first, second, or third grade. We left it to the teacher's judgment as to her ability to work with children and what she knows about children and what they are ready to learn. The concepts, however, persist all the way through the series, and you will find them in high school science teaching. And so you hook on to the maturity of the child where you find him in a particular task. The type of work that I read to you just now, coming out of the second grade of seven-year-olds in San Francisco, reflects the type of job you will find the teachers doing with the children. And these children work with equipment and carry on experiments.

In this training of teachers it is a matter of in-service as well as preservice training. The whole in-service study program today and for some years in the past has been emphasizing what can be done to bring to a teacher breadth and insights in an area in which she feels inadequate. And that is what has been happening in our schools. These science guides were made available in 1948. Ever since then, every year, we have had special courses in science for our teachers and we secure instruction for them from the colleges in our area.

This last year we had a course conducted by personnel in the field of aviation. It was called "Jet Air Transportation and You." As many as 200 teachers in our school system took advantage of 15 sessions in the course. This year we are working with the California Academy of Sciences in presenting a series of courses in natural science.

Let's shift to arithmetic. Elements of arithmetic are not found as easily and readily in everyday language work, social studies, and the fields of study as are elements of science. There isn't so much to talk about in arithmetic. When the elementary school child uses language he has a chance to talk about a wide range of things. But when he is using arithmetic, he is somewhat limited as to its actual use. I think that the difficulties we've had in teaching arithmetic in elementary schools, contrasted with teaching reading and language work, reflects just that. Arithmetic in a child's life is not so apt to be used on an early level to the extent that his language is used.

I don't know how you people learned your arithmetic. I know how I learned mine a good deal as a child. I did it behind my father's counter in his store in a small Indiana town in which the women—the farmers' wives—would bring their eggs into the store to trade them for dry goods. I woulld have to measure off seven yards of calico at 12½ cents a yard. And they didn't seem to want the thing to come out even. If the customer needed only seven-eighths of a yard or half a yard, a frugal farmer's wife would take advantage of that possibility that offered itself. The chickens didn't happen to lay their eggs in dozens either. Maybe there were eleven dozen and ten eggs for which I would have to figure out the cost, and this too helped my arithmetic. And so we in a small town used our arithmetic in many ways. We practiced arithmetic all the time.

A few years ago I watched my own two boys for three months, when they weren't watching, to try to determine what arithmetic they actually used. At that time they were eight and twelve years of age. If you have children of your own,

you might find it interesting to see what is demanded of a child today in the field of arithmetic. In daily life my two boys were asked to make a little change in handling money, and that was nearly all the practical experience they had in arithmetic. It's a little rougher teaching I think, in this field than it is in science. The children are eating up science. I'm really more concerned about how we can pep up the arithmetic program. Let's recall Kenneth whose sentences I quoted to you. He is quite a gifted child, and no doubt you recognized his gifts. Our main problem is not to lose this boy in the shuffle as he goes through school. He's on the track already. He has ideas. He thinks about things around him. He knows how to use language.

Here's a paper in arithmetic that was picked up in a school the other day—the work of a child six years and ten months of age. He was figuring out the value of his family home. He started out with $43,590 for 1957, and he's got the value going up year after year until he gets to 1985. The value of the property then drops $6,000 from what it was the year before. When asked by his teacher what the drop meant, he said, "Depreciation."

Why this particular boy on a few of these valuations adds cents, for example, $47,073.55, nobody knows but the boy himself. He is a boy who is intrigued with arithmetic. He is using it right along. He wrote a couple of plays for the school, and one of these plays is full of rabbits. I suppose because they multiply so rapidly they offered some computation possibilities for him. In his use of numbers the time factor interests him a great deal. Scene I is set at 6:58 a.m., March 2, and so on. And as the rabbits go out to get the carrots with the mother, they have to divide the crop. She wants to get 20 carrots for 5 rabbits, they don't divide right, she helps them to the proper solution, and so on.

This six year old boy has a mind already busy with arithmetical concepts. I'm not worried about him or other children like him because today we are alerted to gifted children; we are conscious of ability. In our staff the research department has such children spotted through the tests that are given. We don't leave it to the chance that the teacher might have caught the significance of the scores on the standardized tests. These records go out to the schools. A given school's attention is called to the fact that so-and-so there has an intelligence quotient or an achievement score of a certain significance.

What we need to recognize is that schools are working in the field of science, definitely, at the elementary level. The approach has shifted from the limited nature study that you and I had when we were in school to a program that offers children greater breadth, more variety, and more realistic application. In the curriculum set up by our school system, all of our books and all of our visual materials are classified on the same plan as that of the course of study in science. Where you have important concepts in the different scientific areas, then the teaching aids are set up on that same structure for ready reference. It was astounding to me when I started to look into this matter to find how many scientific references we do have.

What is the future of this field of science? What is the situation that the school faces today? I think personally that the facts of science and mathematics, regardless of how pure or how infallible, find their true meaning in their application. If learning isn't applied properly, then knowledge has no more significance than gold in the possession of a miser. Today we're not in the process of storing up knowledge but in the process of using knowledge. Literacy in the field of science is a necessary tool of existence.

I'd like to see children in their language work use science, or mathematics, or whatever else it is that they have at hand that seems to invite particular attention. Our increased emphasis on science in the elementary school is not being carried forward at the expense of other departments. These other areas are not going to lose out. I'm not worried about this. All that I would be concerned about in this conference is that we don't accept any fast answers to this problem. Rather, it takes good teachers to work steadily and effectively with children, improving the curriculum year after year. Let's not suddenly pick out something, cut it off, and throw it out as though we have the answer in the thing that immediately replaces it.

# THE PRESENT STATUS AND FUTURE NEEDS OF THE SCIENCE AND MATHEMATICS PROGRAM IN CALIFORNIA SECONDARY SCHOOLS

**NOLAN D. PULLIAM,** ***Superintendent, Stockton Unified School District***

The speakers we heard during the first general session of this conference gave us a comprehensive and authoritative view of the national manpower shortage and its impact on our national security. The relationship of this situation to the programs and plans of our nation's schools is clearly apparent and of deep concern not only to those engaged in the work of education but to the public as a whole. In the process of "stock taking," which was the inevitable result of evidence presented so dramatically that our technical superiority has been at least temporarily challenged by Russia, the public schools, particularly the high schools, have been the object of nationwide scrutiny and the subject of considerable criticism. I believe that responsible teachers, administrators, and members of boards of education will agree that a periodic reappraisal of our school program is an essential part of the process of maintaining a well-balanced and properly directed program of instruction. The thoughtful deliberations of the group of leaders assembled here may well have the effect of pointing up new directions or new emphases that are needed in our public schools and may reaffirm the existing program elements that deserve continued support.

Before reviewing the current status of the high school mathematics and science programs, I believe it is essential to an unbiased appraisal of their merits that we correct certain erroneous impressions that have been given national publicity by those persons who have sought to place the blame for the existing shortage of technically trained personnel upon the schools.

*Charge 1:* That a large proportion of American high schools do not offer courses in physics or chemistry.

*The facts:* "Of all pupils enrolled in the twelfth grade of the public high schools. . . . only 4.8 per cent did not have access to these courses."[1] The large number of small high schools with enrollments of 100 or less per school is largely contributory to the existence of even this small proportion of schools that have limited offerings in science.

*Charge 2:* That student enrollments in science and mathematics are decreasing and are now much lower than enrollments in the year 1900.

*The facts:* As borne out in Table I, the number of students enrolled in high school chemistry in 1900 was 40,084; in 1956 this number had increased to 519,000—a thirteenfold increase. Similarly, the total enrollment of high school students in physics in 1900 was 98,846 and had increased to 309,600 in 1956. A fact often overlooked in such comparisons is that the number of young people attending high schools today represents 60-80 per cent of the eligible age group; in 1900 it represented only about 10 per cent of presumably the ablest youths of high school age.

[1] *Offerings and Enrollments in Science and Mathematics in Public High Schools.* Pamphlet No. 120. Washington, D. C.: U. S. Office of Education, 1956, p. 6.

**TABLE 1**

**COMPARATIVE ENROLLMENTS IN HIGH SCHOOL SCIENCE CLASSES, 1900 AND 1956 ***

| Subject | Enrollments | |
|---|---|---|
| | 1900 | 1956 |
| Chemistry | 40,084 | 519,900 |
| Physics | 98,846 | 309,600 |

* Based on statistics in *Offerings and Enrollments in Science and Mathematics in Public High Schools.* Pamphlet No. 120. Washington, D. C.: U. S. Office of Education, 1956.

Statistics compiled by the U. S. Office of Education show that both numbers and per cents of enrollments in high school mathematics and science courses increased between 1945 and 1956, and that during the school year 1956-57, more students were enrolled in these courses than during any previous year in the nation's history.

Along with concern over enrollments, there has also been some expression of doubt as to the quality of existing public school instruction in mathematics and science. Even though the stoutest defenders of the public school system would agree that its programs have many shortcomings, it is reassuring to learn that 15 of the 16 key scientists who developed America's first satellite, Explorer I, at the California Institute of Technology Jet Propulsion Laboratory are graduates of American public schools.

Another encouraging indication concerning the quality of the public school graduate can be found in the results of a recent survey of the high school backgrounds of students qualifying for Phi Beta Kappa at Harvard and Yale Universities. According to the findings in this study, 59 per cent of such students at Harvard and 54 per cent of such students at Yale were graduates of public schools; and the proportions of public and private school backgrounds for the total university enrollments were 55 per cent and 45 per cent, respectively.

Similarly, a substantial growth in high school science and mathematics enrollments over the past five years is reported for the State of California according to an official statement released in November, 1957, by the State Department of Education. Certain elements of this growth are shown in Table II.

**TABLE 2**

**FIVE-YEAR COMPARISON OF HIGH SCHOOL ENROLLMENTS IN SCIENCE AND MATHEMATICS IN CALIFORNIA***

| Subject | Enrollments | | Per cent increase |
|---|---|---|---|
| | 1951-52 | 1956-57 | |
| Physics, first year | 10,126 | 15,410 | 52.18 |
| Chemistry, first year | 22,743 | 38,337 | 68.57 |
| Plane geometry | 35,764 | 62,464 | 69.06 |
| Total high school enrollments | 390,907 | 572,821 | 47.53 |

* Based on articles, "1951-52 Enrollments of Four-Year, Junior, and Senior High Schools" and "1956-1957 High School Enrollments, Grades 9 Through 12." Bureau of Secondary Education. Sacramento: California State Department of Education (mimeographed).

These incontrovertible facts fail to support the charges I have brought to your attention and should enable us to proceed with some degree of calm to the orderly reappraisal of our existing science and mathematics programs and to make valid suggestions of ways in which they can and should be improved.

First, let us examine the typical requirements for graduation in a California high school. One-half to three-fourths of the courses are specified. One-fourth to one-half of the courses are open to elective choice, and the student has access to recommended lists of electives related to his prospective major field and to the entrance requirements of the college he expects to enter. The student selects his courses with the advice of his subject teacher, his counselor, and his parents.

Typical college preparatory course offerings in mathematics and science in a California high school are as follows: ninth grade—algebra 1, 2; general science; tenth grade—plane geometry 1, 2; biology 1, 2; eleventh grade—intermediate algebra 1, 2; chemistry; twelfth grade—solid geometry, trigonometry; physics 1, 2; senior biology.

A small proportion of California high schools also offer electives of calculus and analytical geometry for advanced students. The mathematics and science courses offered by California public high schools are sufficient in number and content to permit students who wish to major in the fields of engineering and science to meet college entrance requirements.

However, more important than the availability of courses and the extent of enrollment in mathematics and science is the ability of the high school graduate to measure up to collegiate standards in his chosen field. Some indication of the status of California high school graduates may be gained from the annual summary of grades earned by students attending the University of California. The summary is compiled by the University and is referred to the high schools contributing to its enrollment. A review of the most recent University of California summary, covering work for the academic year 1956-57, affords the following pertinent data: The grade-point average of all University of California freshmen for the year was 2.38. The average of all freshmen entrants over the last prior three years was 2.41. The differential in grade average between high school and college grades (three-year average) was —0.98. This information makes clear that the average California high school graduate is entering the University of California with a B-plus average grade and is maintaining a C-plus average.

The information in the University grade report is coded, and therefore interschool comparisons are not readily possible; but since each school can identify its own standing, the report is valuable to the administrative head of any school or school system inasmuch as it provides him with information that can be used as a basis for expanding and improving the programs of instruction that are being offered whenever such need is indicated.

I should like to review a number of recent developments that offer promise of increasing existing enrollments in mathematics and science and show some indication that future programs will be better adapted to current needs.

1. A number of school systems have recently adopted the practice of bringing into the school system consultants from universities or from industry to work with science and mathematics teachers by means of lectures and workshops.

2. The Oak Ridge Institute for Nuclear Science this year is providing the nation's schools with eight highly selected and specially trained science instructors who are assigned on a regional basis to give demonstrations of improved methods of teaching before teachers and classes in high school science.

3. The introduction of new textbooks in science and mathematics has been accelerated with the recognition of recent changes in some of the fundamental concepts in both these fields.

4. Hundreds of opportunities for summer institutes and refresher courses for science and mathematics teachers now in service have been made available through the assistance of the National Science Foundation and through the generous co-operation of numerous industrial firms.

5. Correspondence courses have been introduced to expand the curricular offerings in mathematics and science in small high schools where the numbers enrolled are too limited to permit local school course offerings.

6. The construction of many new science laboratories has made possible improved instructional practice. For example, in our own school system, which enrolls about 10,000 high school students, we have within the past year added one new physical science building at our junior college; new science laboratories in two senior high schools; and well-designed laboratory facilities for both physics and chemistry in a third senior high school which is now under construction. Our district has also constructed two new junior high schools, which include laboratories for ninth-grade general science. Furthermore, in response to the increased interest in science, we have assigned a full-time science teacher to assist in the development of teaching aids in science at the elementary and junior high school levels. An example of modern high school laboratory equipment currently used in our district is a combination chemistry and physics table designed by a group of Stockton science teachers and already adopted by a national manufacturing company. This facility offers a maximum utilization of space and an increase in the number of students one instructor can effectively supervise in a laboratory situation.

7. Another promising development for the stimulation of more widespread interest in science is the science fair, which seems to operate with equal success at either the elementary or the secondary level. Whether operated within a single school or under district-wide, state-wide, or national sponsorship, the science fairs have generated a high degree of student interest and participation. This movement is now fostered and assisted by the Science Clubs of America, which conduct the National Science Fair.

8. Expanding the high school curriculum to include calculus and analytical geometry is a practice that seems well designed to challenge the interests of the ablest students and one that permits them to accelerate their progress through school.

9. Through their national publications, both the National Science Teachers Association and the National Council of Teachers of Mathematics are giving active encouragement and direction to the reappraisal of current offerings and subject content in high school mathematics and science courses. The 1957 Yearbook of the National Council of Teachers of Mathematics, entitled *Insights into Modern Mathematics,* is directed toward the secondary school teachers now in service. It provides for them an introduction to the most recent developments in the science and theory of mathematics. The National Science Teachers Association, with a membership of some 20,000 teachers, is sponsor of the Future Scientists of America Foundation; the Foundation reaches approximately 35,000 high school science teachers, who in turn instruct some 4,000,000 students. The Association is also doing effective work in recruiting able students to enroll in science courses through career information publications.

10. The current efforts of our State Department of Education in conducting its study of teaching credentials and in sponsoring conferences on teacher recruitment are contributing much toward meeting what is generally recognized as an imperative need if any worth-while improvement in our school program is going to be made—namely, the need for providing an adequate supply of fully qualified teachers in all fields of instruction, including science and mathematics.

11. New aids to instruction, such as the excellent series of filmed lectures and demonstration materials in physics, are expected to prove valuable adjuncts to present materials and methods. Likewise, the utilization of the medium of television to enlarge the effectiveness of highly skilled instructors offers great promise for further development.

12. The rocket clubs springing up all over the country are expressive of the potential interest in science among our junior and senior high school age youth. Such a club has been formed in our community and has been named the Future Scientists Club. It is sponsored by a junior high school science teacher on a voluntary basis. Incidentally, this unit has recently been granted a charter in the Rocket Research Institute, a national organization of scientists, because of the safe procedures and efficient training this organization has established in the conduct of its rocket experimentation.

13. The "junior museum," an innovation serving a purpose similar to that of the public library, is a valuable resource that can be used to supplement classroom instruction in physical and natural science.

All these developments are encouraging. On the other hand, we do face certain practical problems that call for solutions if the needs of the science and mathematics program in our schools are going to be met fully and successfully.

1. How can the allocation of high school graduates to fields of science and engineering be increased? This in turn poses a problem of public policy related to education: Shall we rely upon the usual processes of guidance and continue to allow the individual free choice of his vocational objective, or shall we devise and use some means to "direct" the individual into a field where a certain agency—local, state, or national—determines he is needed; shall we continue to allow a free labor market subject to the laws of supply and demand, or shall we proselytize or conscript the workers needed?

2. How can we increase the supply of science and mathematics teachers? The nation's graduating classes of 1955 produced 3,754 qualified teachers of science, of whom only 2,114 actually entered the classroom; similarly, the number of qualified mathematics teachers graduating in 1955 was 2,155, of whom but 1,450 entered teaching.[3] The obvious implication of these losses to teaching is the attraction of better financial rewards in other lines of endeavor. Some have proposed that greater rewards be offered to science and mathematics teachers than those offered to teachers of other branches of instruction. This solution, however, could produce a series of problems of a fundamental and serious nature.

3. How can we effectively provide for the in-service training of science and mathematics teachers who have not yet become familiar with the newer concepts in their fields of instruction?

4. How can we be successful in reducing the number of small high schools that are unable to provide adequate facilities and a sufficient variety of course offerings? Properly equipped science laboratories are expensive. The unit costs are

[3] Ray C. Maul, "Is the Science Teacher Shortage a Curriculum Factor?" *The Science Teacher*, XXIII (May, 1956), 183.

greatly reduced in the larger school, which permits greater daily utilization and optimum size of class.

5. How can we secure the benefits of long-range studies to guide us in avoiding the possible dislocation that would result from over-production of technically trained personnel to meet temporary needs? Some of us can recall the period of the mid-thirties when engineering graduates were in oversupply, and many careers were temporarily blighted.

6. How can we collect and make widely available the essential facts regarding the demand for workers in all types of callings?

7. How can we reduce or eliminate the substantial loss of high-level ability students due to "drop-outs"? In the United States "about 60,000 students of promising ability drop out of high school each year before graduation. Less than half of the top 25 per cent who do graduate now complete college. Only 6 out of 10 of the potentially most promising 5 per cent of high school graduates earn college degrees."[3]

8. How can we, through scholarships or other means, remove the financial barriers that prevent many youths from getting the training they are willing and able to take?

9. Can we maintain a balanced perspective in our current planning—a balance that will result in the upgrading of the total program of education by means of reducing class size, increasing the supply of qualified teachers, and providing adequate facilities, equipment, and materials of instruction consistent with needs in all subject fields? The scientist must be fully equipped to cope with problems that he and all other citizens have in common. To ignore the necessity of a well-rounded educational development for our scientists might mean to develop a Frankenstein monster capable of destroying the society that created him. If education is an essential element of our national security, and it appears to be, this public function must receive a higher priority in the allocation of financial support than it has received to date.

When we consider these problems, we are confronted with the need to develop workable methods toward their solution. What can we project as a plan for the improvement of our high school science and mathematics programs? I should like to suggest several steps that I believe would help to bring about this improvement.

First, let us obtain the facts concerning the adjustments that are needed in the existing programs of instruction in our schools. This is a task in which our professional leaders in the science and mathematics fields are now actively engaged. Such adjustments in programs should take account of (1) the social setting of science and mathematics education; (2) our instructional methods as to how youth learns the facts and principles involved in science and mathematics courses; and (3) how an instructor can utilize a variety of instructional devices to improve understanding of subject content and to raise the level of interest.

Secondly, we need to arrange for leaders in industrial research to co-operate with instructional personnel in vitalizing the curriculums in science and mathematics. This co-operative process should employ the latest materials of instruction that are used in teacher education courses in colleges and universities. Curricular improvement should be paralleled by improvement in the selection processes by which our teachers are chosen. If schools are to keep pace with

[3] *America's Resources of Specialized Talent*, prepared by Gael Wolfle. Report of the Commission on Human Resources and Advanced Training. New York 16: Harper & Bros., 1954, p. 8.

scientific progress, we must revise our secondary school curriculums to correspond with the findings of the specialists. Even though programs may be adequate for the day, we shall always need to make periodic reappraisals of high school program content. It is evident, then, that we must provide for a larger cadre of specialists in education, sciences, and mathematics to assist teachers on the job to make needed adaptation of curriculums or methods.

Thirdly, we need to establish a number of regionally selected centers for continuing research and developments in science and mathematics education. This is an area in which public schools have lacked funds to carry on an active program whereas industry has found it profitable to devote increasing sums to research. If schools are to be capable of providing the technical staffs required for industry, it may be found necessary and profitable to support an adequate research program directed toward the materials, the personnel, and the processes of the training institutions.

Fourthly, we need to establish ways and means for the rapid introduction of new materials made available through research into the curriculums of the secondary schools and into the program of the teacher training institutions.

Finally, we will find it essential to develop plans for financial support within the existing framework of public control—support that will insure a high quality of educational service in every community and state of our nation.

In summary: The current status of enrollments in science and mathematics is not as alarmingly low as some of our critics would have us believe. However, a reappraisal of our present program is not only desirable but should be productive of improvement. The many encouraging evidences of increased student enrollment and enlivened student interest in science give us reason to hope that with the stimulation of the numerous scholarships now available and in prospect, we may confidently expect a substantial increase in the number of students electing mathematics and science majors in the immediate future. Nevertheless, we have numerous unresolved problems that we must face realistically if we are to compete successfully in the "battle of the classrooms." Resolving them calls for certain jobs to be done: offsetting inadequate teacher supply; replacing small and inadequate high schools; providing widespread in-service programs for existing staff; avoiding imbalance as to the number of technicians to be trained in relation to the number of jobs available; providing for more extensive research in science and mathematics education and for dissemination of the results thereof; maintaining a balance in quality of instruction; and, finally, upgrading our total program of education—an achievement that is basically dependent upon an improved foundation of financial support. Whether we make the effort to provide the funds and ensure their application to the improvement of education will depend upon the extent to which we really believe that education provides the key to our nation's security. Russia has apparently acted upon the belief that education is the way for that nation to achieve technological superiority.

Edward R. Murrow, noted news commentator, revealed in a recent interview that 23 years ago Stalin had said, "Education is a weapon. Whom it affects will depend on who holds it in his hand . . . and who is struck by it." Murrow stated, "Today, education is still a weapon and one we can ill afford to neglect." We would not counsel that this nation follow Russia as to the purposes of education or that we copy Russian educational methods. It does seem evident, however, that education must be considered a potentially powerful weapon in the arsenal of freedom.

# POST HIGH SCHOOL MATHEMATICS, SCIENCE, AND ENGINEERING PROGRAMS: PRESENT PRACTICES, TRENDS, AND IMPLICATIONS

**ELLIS A. JARVIS,** *Superintendent of Los Angeles City School Districts*

The three guest speakers from our nation's capital have outlined for us the manpower needs of the United States during the next ten-year period. They have indicated both the absolute and the relative need for employees in the eight major occupational groups, and have demonstrated that our expanding economy will demand primarily better educated and better trained workers.

It is apparent to all of us that the key to meeting our manpower needs lies in providing all Americans the fullest possible education. This presents a challenge that will be of concern to every level of our educational system. The immediate responsibility for providing better trained manpower, however, will fall upon the institutions that offer post high school education. In my community and in the entire State of California a major share of this responsibility will rest with our junior colleges and adult education programs for the following reasons:

1. Our junior colleges are the only publicly supported post high school institutions that 57 per cent of our high school graduates can attend, for the entrance requirements of the University of California and the state colleges are such that only 43 per cent of all high school graduates are eligible to attend these institutions of higher learning. As the University and the state colleges become more crowded in the years ahead, it is reasonable to assume that their requirements for entrance will be raised and that the per cent of graduates who can meet the requirements will decrease.

2. Three-fifths of all full-time students in grades thirteen and fourteen (those in the lower division of college) are enrolled in junior colleges. The campuses of the University of California accommodate only one in nine of such students; the state colleges enroll only one in eight.[1] Enrollments in California junior colleges in October, 1957, totaled 267,882 students. Of this total, 80,916 were full-time students, 51,781 were part-time students, and 135,185 were students enrolled in extended day (adult education) programs.[2]

The purpose of this conference is to examine our present and future needs for science and mathematics education and to appraise the current and potential contribution of the public schools in meeting these needs. It is obvious, however, that we cannot discuss this problem in a vacuum. The problem must be considered in relation to the manpower needs of our nation for better-trained and better-educated workers. Furthermore, we cannot outline a program for the future without examining the extent to which we are now meeting manpower needs.

What are the junior colleges in California doing to meet the manpower needs of our state? In answering this question, I will of necessity confine my remarks

[1] Roy E. Simpson, "Changing Times and the Secondary School Program," *California Schools*, XXVII (July, 1956), 257.

[2] "Enrollment in California Public Schools, October 31, 1957," *California Schools*, XXIX (February, 1958), 73.

to the programs of the Los Angeles city junior colleges although I know that the situation is comparable in the other junior college districts.

Our seven junior colleges[3] offer more than 200 different occupational training programs. These programs are designed to meet the needs of our community for the following types of workers who can be trained successfully in a period of two years or less for initial placement:

1. *Craftsmen and technicians.* Programs in this area include Architectural Drafting, Automation, Electronics, Engineering Aide, Refrigeration and Air-Conditioning, Petroleum Refining, and Tool Engineering.
2. *Clerical and sales personnel and proprietors and managers.* Programs in this area include Accounting, Business Administration, Office Machines, Merchandising and Selling, Secretarial Science, and Supervisory Management.
3. *Farmers and farm workers.* Programs in this area include Animal Science, Dairy Husbandry, Dairy Manufacturing, Fruit and Truck Crops, and Poultry Husbandry.
4. *Semiprofessional workers.* Programs in this area include Vocational Nursing, Police Science, Dental Assistants, Medical Laboratory Assistants, and Social Welfare Aides.
5. *Service workers.* Programs in this area include Baking, Cosmetology, Home Catering, Men's Tailoring, and Spotting and Pressing.

Practically all of the occupational training programs require certain types of mathematics and science education. The types and amounts of such training, however, are recommended by the lay advisory committees that guide the operation of these programs. In our district, all occupational training programs, including trade extension programs and apprentice training programs, are developed with the assistance of lay advisory committees composed of employers and other experts in particular fields. At the initial meetings of these committees, the content of the training program is established, while at subsequent annual meetings the content is re-evaluated and possibly adjusted to meet changing needs of industry.

I am told that there is a trend on the part of these advisory committees to add to the training programs further instruction in science and mathematics and more advanced courses in each of the areas. This trend is reported to be especially noticeable in the technical training programs.

In addition to the occupational training programs, preprofessional training to meet the needs of our community for professional persons is offered by five of our junior colleges. By "preprofessional training" we mean that these colleges offer the lower-division courses required for junior standing at the University of California, the 11 state colleges, and the various private colleges and universities in the state.

That the junior college makes a significant contribution to our manpower needs through its transfer programs is made apparent by the report that more than half of the upper-division enrollment at the University of California, Los Angeles, consists of junior college transfer students.

Of special interest to this conference will be the fact that the largest single group of preprofessional majors in our junior colleges are engineering majors,

[3] Total enrollment, 57,387 students at the beginning of the fall 1957 semester. Of this number, 21,114 were either full-time or part-time students enrolled in programs offered during the regular day program; an additional 36,273 were extended day class students enrolled in courses offered during the hours from 4:00 p.m. to 10:00 p.m.

and the number of such majors[4] is increasing each year. City College recently reported a 200 per cent increase in transfer-type engineering majors during the period from the spring 1954 semester to the spring 1957 semester, while East Los Angeles Junior College reported a 174 per cent increase during the same period. Similar increases were reported by the three other of our colleges offering preprofessional training.

Other transfer majors in which a significant number of our students are enrolled include business administration, education, and nursing.[5] Lesser numbers are enrolled, however, in every possible major from art to veterinary medicine.

The increased interest of our students in engineering as a career may well account for the per cent of our regular day students who were enrolled during the fall 1957 semester in courses in mathematics and science since 21 per cent (4,204) were enrolled in chemistry courses, 32 per cent (6,478) were enrolled in mathematics courses, and 18 per cent (3,641) were enrolled in physics courses.

Furthermore, the current enrollments in mathematics and science courses are the result of an upward trend. City College reports that enrollments in mathematics courses from the fall 1953 semester to the fall 1957 semester increased 59 per cent (from 1,952 to 3,099 students), and enrollments in physics courses during the same period increased 87 per cent (from 634 to 1,195). A similar study made at Harbor Junior College for the period extending from the fall 1954 semester to the fall, 1957 semester showed a 300 per cent increase in enrollments in engineering, mathematics, and science courses. The increase in enrollments at Harbor Junior College in mathematics courses alone was from 408 students to 1,353 students.

The third way in which we are attempting to meet the manpower needs of our community is through an extensive program of adult education. The over-all objective of this program is to provide persons employed full time with opportunities to pursue educational objectives during their leisure hours. The primary function of the program, however, is to offer courses that assist persons to upgrade themselves in their present positions or to prepare for employment in new fields. Meeting the needs of our community for this type of training is the joint responsibility of our seven junior colleges and of our 26 schools for adult education. Both types of institutions are administered by our Division of Extension and Higher Education.

During the past semester, 36,273 persons were enrolled in courses offered by the junior colleges in our area during the hours from 4:00 p.m. to 10:00 p.m. This number included some 13,000 persons who were taking trade extension courses or apprentice-related training. At the same time, more than 64,542 adults were enrolled in courses offered in our 26 schools for adult education. This number included 12,000 persons taking either trade extension or apprentice-related training.

It should be pointed out that persons enrolled in our adult education programs may be pursuing the same educational objectives as our regular day students are pursuing, but at a much slower pace. For example, a comparative study of educational objectives of regular day students and students in extended day classes at Harbor Junior College disclosed that the per cent of extended day class stu-

[4] A total of 2,196 in the five junior colleges. This total represents approximately 13 per cent of the regular day enrollment of some 17,000 students in these five colleges.

[5] East Los Angeles Junior College alone has some 400 students enrolled in the one-year vocational nursing program (143); in the new two-year R.N. program (20); and in the three-, four-, and five-year transfer programs.

dents enrolled as transfer majors in engineering, business administration, and education is the same as that of regular day students so enrolled. In addition, our junior colleges report that enrollments in courses in engineering, mathematics, and physical science in their extended day programs have increased in the same relative proportion as in the regular day programs.

An increase in demand for classes in mathematics and science has been reported by our schools for adult education. From 1954 to the present, the number of classes in science has increased 96 per cent; the number of classes in mathematics has increased 81 per cent.

I cannot move on to my next point without calling your attention to a very special contribution being made to the educational upgrading of our population by our adult education schools. Last year our schools for adult education conferred high school diplomas on 2,019 adults—a figure representing one-ninth of the total number of high school graduates in our entire school system. We believe this contribution is especially noteworthy when it is considered that, according to the 1952 census, 61 per cent of the adults over 25 years of age in the United States have less than a high school education.

In my presentation I have outlined how our junior colleges are attempting to meet the manpower needs of our community through a program that provides occupational training, preprofessional training, and a program of adult education that complements the offerings of our 26 adult education schools.

At this point I would like to present the following evidence that our program has been successful:

1. Studies conducted by the University of California have established that our transfer students who were eligible to attend the University upon graduation from high school but who elected to attend a junior college instead, do as well during their junior and senior years as do the native students who enrolled at the University as freshmen.

2. Industry in our community is on record as approving the quality of our graduates who were trained to be technicians or craftsmen. On its own initiative, the Merchants and Manufacturers Association conducted a survey of its members in 1955 to determine the quality of our technical-vocational training programs as measured by the success on the job of the graduates. The results of the survey established that the graduates of our training programs were not only highly qualified and satisfactory employees but individuals who were given better beginning positions because of their junior college training and were subsequently given first consideration for promotions for the same reason.

By 1965 we will have twice as many students enrolled in our junior colleges as were enrolled in 1955. More important to this conference, however, is the fact that enrollments in science and mathematics courses may have to be three or four times the current enrollments in these courses if we are to meet our manpower needs during the next decade. According to the manpower report,[6] our economy will need a greater per cent increase of professional persons, including engineers and technicians, than any other group of workers. It is the professional worker and the technician who need the most training in the sciences and in mathematics.

Meeting this increased need will require a planned program on some regional basis of industry-education co-operation. A program of this type is suggested as follows:

[6] *Our Manpower Future, 1955-65.* Washington, D. C.: U. S. Department of Labor, 1957.

1. Industry must be willing to release its scientific and engineering personnel to teach part-time in the regular day program of our junior colleges. We cannot now secure from the training institutions an adequate supply of instructors qualified to teach mathematics and science courses, and we cannot continue much longer to draw upon our high schools for instructor personnel without damage to the high school program. Industry has accepted this responsibility in our community, and we now have qualified personnel from industry teaching science and mathematics classes during the regular day sessions in our junior colleges.

2. Industry will have to assist us with improving the quality of instruction in the classroom. In our industry-education program, industry is providing lecture-demonstration teams to visit our high school science classrooms to explain the latest developments in the fields of science and to demonstrate the latest scientific equipment. This latter service is especially important because a public school cannot afford to purchase equipment that may, in a few weeks, be obsolete.

3. Industry should be able to assist us with an evaluation of the content of our present mathematics and science courses. I know that the transfer mathematics and science courses that we offer in the junior college are what the four-year colleges and universities specify we must offer. But I would suspect that a co-operative industry-education evaluation of these courses could be profitably undertaken in our junior colleges and colleges and universities. I am unable to understand completely, for example, why industry states that the student enrolled in a regular day technical training program must complete the traditional courses in mathematics but considers the same student enrolled as an apprentice student or trade extension student fully qualified when he completes only condensed versions of the same courses offered as related training in our extended day programs.

4. Industry-education co-operation is needed to determine the definition of "technician" and the type of training needed to produce a technician. It is clear that industry has a great need for technicians and is calling our attention to this need. And yet I am told that it is becoming increasingly difficult to interest students in enrolling in this type of training program and that our colleges are discouraged in their attempts to meet this need of industry for the following reasons: (a) industry does not yet have a salary schedule for technicians that is commensurate with the skills and knowledge possessed by the graduates of our two-year technical training programs; and (b) industry itself is unable to agree on what constitutes a technician or to indicate adequately to our junior colleges the type of training required. Some industries define "technician" as a five-year graduate engineer; others consider him to be a two-year engineer; still others apparently assign the term "technician" to the unskilled laborer who performs routine assembly functions.

5. We must develop and maintain continuous communications between industry and the junior college and between the junior college and the public in order that (a) we in the junior colleges will know the actual and relative needs of our community for better-trained and better-educated personnel; (b) industry will know to what extent junior colleges are attempting to meet and are equipped to meet its needs; and (c) the public will understand the manpower needs of the community and will appreciate and support the attempts being made by the junior colleges to meet these needs.

6. The junior college educator must not only be receptive to the assistance that industry has proven willing to give to our educational program; he must also take

the initiative in developing techniques for the effective utilization of the "package deal" that industry can deliver into his classrooms. Given extreme good will and co-operative attitudes among business, industry, and education, it is still necessary to work out the specifics of how mutual assistance may be effected. A high degree of organization is necessary to prevent lost motion and wasted effort. How "what the schools need" and "what business and industry have to offer" may be geared into the most efficient relationships is the continuing question. Much has been accomplished; much remains to be done. Education must furnish leadership and staff in the furtherance of these highly beneficial reciprocal relationships.

# MATCHING THE SCHOOLS' PRODUCT TO SOCIETY'S NEED

**JAY DAVIS CONNER,** ***Associate Superintendent of Public Instruction; and Chief, Division of Instruction***

This morning you heard presentations concerning the needs of industry and the armed forces and a discussion of the problems the nation faces because of expanding population. This afternoon you heard detailed descriptions of attempts to meet, through the programs offered by the public schools at three major educational levels, the needs that exist and those that will evolve from the problem with which we are faced.

I believe my function in this program is to assist you in approaching your work in the section meetings tomorrow by suggesting some handles by which you can take hold of the problem of bringing needs and programs together. Therefore, I'm going to direct my comments toward four aspects of the problem that I think you will need to take into account.

The first thing to consider is the system—the structure of public education. Is it consistent with our conception of American society, and is it adequate to serve our needs as we now see them? Secondly, we must give consideration to the school population—the pupils who are served by our schools. Thirdly, we have to take into account the human element— those through whom the service is rendered—and the instructional materials used by them. Therefore, we must give consideration to finding, training, and keeping at a high pitch of efficiency the teacher personnel who man our schools; and we must evaluate the materials with which they and their pupils work. And finally, we must consider the element of time.

The structure for education in America consists of institutions at three levels. First there is a common school program—for all children from kindergarten through grade eight. This elementary school program serves children between the ages of five and fourteen. The elementary school is followed by the comprehensive high school for all youth between the ages of fourteen and eighteen, a coeducational system of schools offering a selection of curriculum patterns, but with some freedom of movement between the patterns. The curriculum patterns which characterize the typical American high school are those which lead to: (1) a liberal arts education at undergraduate and graduate levels; (2) college entrance and specialized study in science and engineering; (3) business and commercial training, with occupational preparation; (4) entrance into trade and industry; (5) homemaking; and (6) agricultural occupations.

Secondly, beyond the four years of high school education we find that differentiation exists in the kinds of institutions and programs which are available for young people. There are four principal types of these institutions for post high school or higher education. First, there is the junior college, a coeducational comprehensive community college with varied curriculum patterns to meet the needs of both terminal and transfer students. Secondly, there is the program of adult education which serves the needs of adult, and for the most part employed workers, for refresher or specific short-term training, for job advancement, or for personal improvement. Adult education programs draw students from the post

high school population, and operate mostly through the facilities of high schools and junior colleges; in some instances with their own separate facilities.

In the third place, there is the system of state colleges which were originally designed for the purpose of teacher education but which also offer programs in liberal arts, and are more recently expanding into the fields of economics, engineering, and occupational training below the level of research specialization. The state colleges also offer extension services. The fourth type of institution, the state university with its eight campuses, is characterized by a higher degree of specialization in its separate colleges or schools. It also offers a university extension service to post high school students. Lastly, there are the private and independent schools in California which offer services paralleling the public tax-supported institutions.

Now these are the school systems through which we offer education in our country. Perhaps it would be well for us to make a few comparisons between the American system and those of other world powers. In most other leading nations of the world, specialization of educational training begins earlier and is conducted on a more intensive basis, for fewer people. In America, students begin to prepare for specialization when they are about fourteen years old, in comprehensive high schools where students mingle freely on a basis of social equality while pursuing different curriculum patterns. In European schools, most children are segregated, between the ages of eleven and fourteen, on the basis of intellectual capacity and social status.

It is also interesting to note that Russia maintains a common school program over a longer period than we do—a 10-year period spanning the age group from seven to seventeen. Young people in Russia enter specialized training institutions, therefore, one year earlier than most Americans. Since there is a much narrower spread of offerings in the common schools of Russia, there is less diversification in training, and more concentration upon college preparatory work. The one-year differential in college preparation is more than compensated for by the much more rigid school program in the Russian schools. In grades nine and above, for example, they operate on the basis of a seven-hour school day, a six-day week, and a ten-month school year. Russian students entering schools of higher education are deemed ready for immediate specialization and spend about 80 per cent of their time in that specialization during the entire four to six-year period of college training.

We should give some attention to significant current trends in American education. Recently voiced fears about students avoiding scientific and mathematical subjects do not seem to be justified in the light of facts. Mr. Pulliam [1] referred to the fact that a study of enrollment of high school students in various courses over a span of nearly 60 years, in the United States and particularly in California, shows that a higher per cent of high school students today are selecting the so-called hard subjects—mathematics, science, and languages than at the turn of the century even though the students who entered high school in 1900 were generally college bound.

You have been given similar figures showing the trends in high school enrollments from 1951 to the present. These figures show that in California high schools, enrollments in mathematics courses almost doubled from 1951 through 1956. The statistics show the per cents of increase in mathematics course enroll-

[1] Nolan D. Pulliam, "Status of Science and Mathematics Education in the Public Junior and Senior High Schools," pp. 316-22, this issue.

ments in the eight-year interval between 1948-49 and 1956-57, ranging from 30 per cent in advanced algebra to 83 per cent in trigonometry. Of even greater significance, perhaps, are the increases that have taken place within the last year in California. In a single year, we had the following per cents of increase in enrollment: in beginning algebra, nearly 8 per cent; in advanced algebra, 18 per cent; trigonometry and solid geometry, 30.8 per cent; chemistry, 14 per cent; and laboratory physics, 7 per cent.

These statistics are given additional meaning and significance by trends in other curriculum offerings of our high schools. For some years now we have been aware that a significant shift of emphasis is taking place in vocational education. High school enrollments in reimbursed vocational courses have not been keeping up with our population increase, and have in some courses remained stationary or decreased. On the other hand, enrollments in reimbursed vocational training courses for older, and particularly for employed workers, are increasing at a rapid and continuously accelerating rate. Nearly 500 additional courses in the adult education program were provided, last year, for this type of training. This morning, Mrs. Wickens [2] pointed out that the retraining of employed workers is a trend over the entire nation. In this trend we see a true reflection of the changing needs of American industry, agriculture and business. All of these occupational fields are making new demands for technical training beyond the manipulative skills of the various crafts and trades. There is today less employment need for and hence less opportunity for the individual who is equipped only with a manipulative skill. Today, advancement in almost any occupational field demands related technical and scientific training in addition to fundamental skills. Hence, employed workers are coming back to school for training, for personal improvement, and for on-the-job advancement.

We need to consider, as we take hold of this problem, the student population and the distribution of ability, interest and productive potential that it represents. Guidance is the key to channeling our student population to meet the manpower requirements of our country in a time of changing conditions. The use of public education to supply trained personnel must be kept within the framework of American customs, ideals, and attitudes. Our society is characterized by devotion to the idea of freedom for the individual to select his occupational field and freedom for each person to choose the method by which he will seek to achieve his own self-realization. We cannot order anyone to select a field of specialization which does not appeal to him. Russia can do this and is doing it. Some other countries, nominally democratic, achieve virtually the same end by raising arbitrary barriers which effectively prevent educational choice by the individual. Both these alternatives are anathema to the American citizen who takes seriously the principle of equal educational opportunity and equal access to cultural pursuits, regardless of his occupation.

Guidance, therefore, is one means by which individuals can be influenced in their personal choices. Guidance, in the sense in which I am using it, is a very broad term. I do not mean it to be defined solely in the terms of the activity of any group of specialized school workers. School counselors, psychologists, and psychometrists all have very important functions to perform. They assist the student in gathering all the data which will help him to make an intelligent choice of a career. They can help him assess his own facilities and relate these to his

[2] Aryness Joy Wickens, "The Nation's Manpower Needs: A Challenge to Education," pp. 299-306, this issue.

aptitudes, to employment opportunities, and to his own personal and financial resources. In the last analysis, counselors and guidance personnel can do no more than help an individual synthesize the factors which are already present in his situation. Guidance is the result of all the factors which impinge on and play a part in creating the attitudes, the sense of values, the ambitions and the desires of the individual.

Today, it is common, in some quarters, to criticize American youth for lacking a clear sense of direction and for drifting, and postponing decisions about vocational futures. This is indeed a problem—one which brings gray hair to educators as well as to many parents. To whatever extent it exists, it is not so much a criticism of either youth or the schools, as it is a commentary on our entire society and our times. Our economic life has become so terribly complex and diversified, its technical aspects so remote and so unavailable to young people in the process of growing up, that there is for most no grasp, no way by which they can comprehend the world of work. Unfortunately, the average family today is in no better situation to give sound counsel and advice. How can I, as a father, advise my son about various fields of employment when I know almost nothing about them?

A great deal of guidance is coming to youth today merely through this kind of public discussion of our manpower and our national needs. I believe the current large increase in enrollments in mathematics and sciences courses in our high schools and junior colleges reflects this source of guidance and stimulation.

However, a more subtle and, in the long run, a more effective kind of guidance is represented in the kinds of recognition and rewards which society gives to various occupational fields. Society puts a price tag on various occupations to which it attaches status and prestige. In Russia, the highest earning power in the country, outside of the party itself, is found among the scientists. Teachers are second in earning power. Thus financial reward and prestige become part of national policy.

In America we cannot move so directly and so drastically in meeting the needs of our national security and welfare. Nevertheless, we cannot ignore the fact that because we must rely on voluntary selection of vocation by our youth in school, we have even greater need than totalitarian societies do to adjust factors of status, prestige, and financial rewards to our national need for trained manpower.

Another problem is how to achieve uniformly high quality of teaching personnel and of instructional material, including course requirements, textbooks, and teaching methods and procedures. Since the next speaker[3] will deal specifically with the problems of teacher training, supply and demand, and teacher recruitment, I will not deal with this aspect of the problem. You may wish to give some attention to the matter of minimum standards for courses of instruction—what quality controls should be required for both courses and textbooks.

Another problem that you will want to take into consideration is the question of the means by which we can speed up the processes of training people for the manpower needs of the years ahead. We can approach this problem in two ways—qualitatively and quantitatively. Qualitatively, through the careful appraisal of our courses of instruction—quantitatively, in terms of the amount of time and effort devoted to teaching and learning. How can we get the time to do a better job than we are now doing?

[3] J. Burton Vasche, "The Education of Science and Mathematics Teachers," pp. 335-338, this issue.

We can gain time in two ways: first, by reviewing very carefully the things to which we are giving time in our present program—by ruthlessly weeding out that which can be discarded or which can be relegated to a place of secondary importance in order to substitute something that we think is more important; and secondly, we can consider changing the length of the school day and the school year.

Now, in summary, I am going to make some suggestions that may be taken into consideration in your attempt to find answers to four major aspects of the total problem. First, I suggest a review and reappraisal of the existing minimum school day requirement of 240 minutes above grade two, exclusive of intermissions and recess. New York has a five and one-half hour school day for elementary and secondary schools, and is presently recommending consideration of increasing the school day at the high school level by one hour. I suggest a review and reappraisal of the existing minimum school year requirement of 175 days of instruction, exclusive of holidays. In terms of a 20-day school month, this amounts to an eight and three-quarter month utilization of the available school year. Again, I refer to New York, which has a 190-day year, but since this includes legal holidays it is hard to determine exactly the minimum number of days that schools must be in session. Russian schools operate on a six-day week, ten-month year; and provide approximately a 240-day year, or a school year about one-third longer than our present minimum school year. In addition, they have a seven-hour school day, compared with our school day of four or five hours.

The next subject I would suggest would be a review and appraisal of our present use of school facilities during the summer period, with possible encouragement of use of these facilities for purposes of remedial instruction, and for the acceleration of high school students.

Already mentioned a number of times in other addresses but I think wise to repeat, is the need for improvement of our facilities and methods for the education of our gifted and superior children. This matter should be considered in two dimensions. First, the enrichment of our offerings so that these gifted children can work at greater depth during the time that they are in regular classes; and secondly, some method of acceleration—some way to decrease the amount of time that gifted children must spend in the high school before they can commence the process of specialization in terms of their ultimate occupational choices. Any consideration of acceleration will lead to the next problem, which is the one of producing better co-ordination between the high schools and the colleges of our state in order to deal with these special cases of superior and gifted children. There must be some way to eliminate the requirements for lower division work which is needless repetition of high school courses during the college freshman and sophomore years. While this repetition may be necessary for some students, it is a waste of time and a source of discouragement for the more able students who are both competent and anxious to start serious concentration of study in their chosen fields of specialization.

The next item, which has been referred to by almost every speaker at this conference, is that more attention must be given to in-service education and to on-the-job improvement for our teaching force. Teachers must keep up with current developments in science, in mathematics, and in our technical life. Because of the rapidity of change, because of our teacher shortage, and because of the immediacy and intensity of our national need for better teaching, I do not think we can rely solely on voluntary attendance at summer training courses;

upon the usual incentives of salary increments; or upon credential requirements to provide for the needed in-service education. I am sure that we must give careful consideration to the reimbursement of selected and worthy teachers for the cost of tuition, travel, and board and room to acquire needed additional training. Many experiments have shown the value of such training.

I suggest also that you consider the ways by which we can improve and strengthen our counseling and guidance services. Mr. Meyerhoff,[4] this morning, referred to a school in which there was one counselor for 1,200 senior students. This is an extreme case, but the cost of adequate counseling should be measured against the cost of the tremendous waste resulting from the aimless drifting of students who are not prepared to make occupational choices. We must eliminate as much of this waste as possible. Waste of teachers and students occurs whenever choices are made which are not realistic in terms of the capacity of the individual, his resources and ability to carry through, or his interests.

There must be a better co-ordination of curriculum planning between different fields and levels. It is just as important to eliminate courses and course content of minor significance as it is to identify the points at which emphasis should be increased. The big question, of course, is the one of time. We might well consider the value and importance of the proposal of the State Curriculum Commission of California for a program of science instruction beginning at grade one and continuing through grade eight, with basic and supplementary textbooks appropriate to such a program. This recommendation has just been made to the State Board of Education and has not as yet been acted upon by that body. It is of the greatest significance.

It would seem to me that in giving thought to these problems you might well find solutions that would point toward an action program involving every person who is interested in and concerned with public education. I am sure such suggestions will stimulate thoughtful consideration by teachers, school administrators, teacher education institutions, school boards, industry, and all citizens.

[4] Howard A. Meyerhoff, "Education in an Age of Technology," pp. 286-90, this issue.

# THE EDUCATION OF SCIENCE AND MATHEMATICS TEACHERS

**J. BURTON VASCHE**, *Associate Superintendent of Public Instruction; and Chief, Division of State Colleges and Teacher Education*

If we are to have good instruction in the sciences and in mathematics, we must first have enough good elementary and secondary school teachers. The shortage of teachers in California has become critical partly because of the tremendous recent increases in school population. It took California 90 years (1849-1940) to enroll one million pupils in its public schools, and 13 years (1940-1953) to enroll its second million pupils; within the past five years (1953-1958) California has enrolled over three million pupils; and it is estimated that within the seven-year period (1958-1965) immediately ahead, California will enroll its four-millionth pupil.

This rapidly growing school population requires from 15,000 to 17,000 new elementary and secondary school teachers a year. Approximately one-half of our new teachers come to California from out of state. Our problem is further complicated by the fact that many graduates of California teacher education institutions do not enter school service.

Growth at the college level presents similar problems. A study just completed indicates that between 1958 and 1970, California will need more than 40,000 new teachers for its junior colleges, state colleges, University of California, and private colleges and universities.

The fields of mathematics and science (only two of the 14 broad subject areas taught in our California high schools), employ nearly 20 per cent of all full-time, high school teachers. In the junior colleges, 23 per cent of the teachers are in these two fields. This year there are over 3,900 full-time mathematics teachers and 2,800 science teachers in our California high schools. In the junior colleges there are about 300 full-time mathematics teachers and 650 science teachers. To replace those leaving the profession, and to fill the teaching positions created by enrollment growth and course additions, we will need 385 new mathematics teachers, and 277 new science teachers in our high schools in 1959; and the junior colleges will require an additional 65 mathematics teachers and 98 science teachers.

Reports from our teacher education institutions indicate that there will be a 28 per cent decrease this year in the number of candidates expected to complete their training as teachers of science; and a 53 per cent increase in the number of mathematics teachers graduating. Shortages exist for life science and general science teachers, and the need is critical for mathematics and physical science teachers in secondary schools. I know that this conference will devote considerable attention to this problem. We must be concerned not only with providing a balanced supply of trained teachers, but it is imperative that quality must be improved and maintained in every segment of the teacher education program.

To teach science and mathematics in an elementary school in California one must hold a general elementary credential. This credential requires four years of study leading to a bachelor's degree, including 24 semester hours of work in professional education. The professional education work is intended to provide adequate preparation for and skill in teaching elementary school subjects.

In our 10 state colleges a student must complete 45 semester hours in general education courses, at the lower division level. This includes work in social science, natural science, literature, philosophy or the arts, health and physical education, oral and written expression, and psychology. Nine of these semester hours must be taken in the natural sciences to fulfill the general education requirement. In addition, an elementary school teacher must complete 24 semester units in a major field, and have at least one 12-unit minor. Additional units to complete the 124 semester hours required for a bachelor's degree may be taken in fields of primary interest to the student. Our state colleges offer a wide range of courses in mathematics and in the physical and life sciences.

The prospective elementary school teacher who takes his training in a state college, completes from 11 to 17 units of course work in science and mathematics. Differences in requirements are based upon the specific course pattern of the college at which the student studies. Since the elementary school teacher is required to teach a wide variety of subjects, it would seem that the requirement in science and mathematics is reasonably sound for the beginning teacher. Many elementary school teachers have a special interest in science, and take advanced courses in the field.

For the general secondary credential for high school teaching, a student must hold a bachelor's degree, and complete a fifth year of 30 semester hours of advanced work. Again, the student is required to have at least one major and one minor in teaching fields commonly taught in the California senior or four-year high schools. The minimum requirement for a major is 36 semester hours of upper division and graduate work. The minimum requirement for a minor is 20 semester hours. Majors and minors may be selected from the life sciences, physical sciences, and mathematics.

Both the high schools and junior colleges of California have developed, within the past two years, procedures for evaluating the effectiveness of instruction. As this accreditation program advances, it is certain that greater emphasis will be placed upon the assignment of teachers to their special fields of competence. This certainly is most significant for those individuals teaching in such fields as mathematics and science. The performance of high school graduates in college and university classes is one check on the effectiveness of instruction in the high schools, and relates directly to the competence of teachers.

At the present time there are 38 institutions accredited in California for the training of teachers. To receive accreditation for teacher education, an institution must have its basic program approved both by the Western College Association and by the California State Board of Education.

There are a number of other developments which I am sure will be of interest to you.

A number of years ago Roy E. Simpson, State Superintendent of Public Instruction, recognized the need to look critically at our whole teacher training and certification process. As a result, Dr. Simpson and the President of the California Council on Teacher Education [1] jointly appointed a state-wide committee to study the credential structure. This committee has recently released a report [2] proposing the establishment of a single basic credential which would require a strong foundation in general education, and clearly defined requirements for

[1] Arnold E. Joyal, President, Fresno State College; and President of the California Council on Teacher Education, 1954.

[2] "Final Report of the Committee on Revision of the Credential Structure in California." Sacramento 14: California State Department of Education, 1957.

majors in academic fields. The report of this committee is now under study by college and university faculties, by the teaching profession, and by interested lay organizations. It is our hope that as California continues to improve its services in teacher education, it will insure the full competence of every teacher in the field of his or her assignment. Your suggestions will be deeply appreciated.

Nine of our colleges and universities currently have special teacher education projects under way for holders of bachelor's degrees who have not had previous teacher training, but who desire now to teach. These individuals are mature persons, above average in background and ability, and they are succeeding well in these speed-up programs. The usual pattern is for these advanced students to take a concentrated summer course; work in a local school system on an intern basis for the school year; and return to the campus to complete requirements for the credential the following summer. The California State Board of Education has established a special method for credentialing these people; and in most cases they may be employed as teachers by local school districts, given assignments as are other teachers, and remain free to call upon the colleges for assistance when they need it.

It is our feeling that in fields such as science and mathematics, much is to be gained by attracting to the teaching profession persons with specific competencies in these areas, even though they may lack earlier training as teachers. We hope that we may continue to experiment in this general field since our recent efforts in this direction have been most successful.

I am also pleased to report to you today that summer workshops for high school and college teachers in science and mathematics will again be offered at five California institutions. These programs are sponsored by the National Science Foundation and are designed to provide a chance for teachers to learn at firsthand about the rapidly advancing developments in these fields. The 1958 summer workshops will be held at the University of California, Berkeley, at the University of California, Los Angeles, at Claremont College, at San Jose State College, and at the University of Southern California. Teaching fields covered by one or more of the institutes include biology, chemistry, earth sciences, general science, mathematics, and physics. An institute on radiation biology for high school teachers jointly sponsored by the National Science Foundation and the Atomic Energy Commission, will be held at the University of California, Los Angeles. These various workshops offer financial inducements to cover expenses of the participating teachers. This is indicative of the kind of program that we must encourage. Programs of this kind most certainly have proven their value and must be encouraged.

It is also interesting to note the work being done for teachers of science and mathematics in local and county school departments throughout California by curriculum committees which have been at work in these fields. Participation in such activity provides opportunities for teachers to keep abreast of developments.

Within recent months there has been a definite upsurge of interest on the part of the schools on the one hand, and industry and the armed forces on the other, in guiding classroom teachers to a more comprehensive understanding of current technological and defense efforts. Such activities must be encouraged at the community level. There has been a marked increase in the utilization of films, in the conducting of workshops, and in the review of school and college courses, particularly as they relate to current needs in science and mathematics.

There are many problems as well as opportunities for teachers in the 63 junior colleges of California. There is first the matter of the large number of teachers required for these growing institutions; and also the requirement that junior college courses be geared to the needs of the local community and its changing technology and economy.

California had 98,200 high school graduates in June, 1956. In 1970, we will have more than 257,000 young men and women receiving high school diplomas.

With this tremendous increase in numbers, it is imperative, I think, that we concern ourselves with the following specific responsibilities and objectives.

1. We must develop a balanced supply of well qualified teachers in mathematics and science for the elementary schools, the high schools, the junior colleges, and the colleges and universities.
2. We must embark upon a vigorous recruitment campaign to encourage outstanding young people to enter the teaching profession.
3. Our schools must not only attract, but they must hold qualified teachers.
4. A broad program of in-service training must be made available to keep teachers abreast of developments in the fields of science and mathematics.
5. It is essential that adequate salaries, and opportunities for continued professional development be made available to science and mathematics teachers.
6. Schools and colleges must co-operate with industry in sharing materials, facilities, and personnel, both in pre-service and in-service education of teachers.
7. Science and mathematics programs in schools and colleges should utilize many of the new developments in instructional procedures pioneered by industry.
8. Basic college and university courses in science and mathematics, particularly those dealing with the teaching of these subjects, must be kept up-to-date in relationship to the latest research and practice.
9. Scholarships and other grants-in-aid should be available for teachers, for prospective teachers, and for colleges and universities, as a stimulant to most effective teacher education.
10. Only as education, scientific institutions, industry, and the armed forces cooperate, can progress be made toward developing a balanced supply of qualified teachers in science and mathematics.

We can well be proud of the outstanding contributions which our nation's teachers, schools, and colleges have made to the development and security of the country. The future of our state and nation may well rest upon the ability of teachers and scientists in research and industry to work closer together on behalf of our great common goal. The launching of our first satellite certainly has stimulated increased interest in science on the part of our schools, colleges, students, and teachers.

We would expect, therefore, that the present interest in science represents not the end, but the beginning, of a working partnership between all people in all fields dedicated to further advancements in education and technology.

We anticipate that key leaders will continue their efforts to produce a larger body of well qualified teachers who would carry responsibility for providing instruction in the classrooms and would recognize those promising young students who should follow science as a career. I trust that this conference will make specific recommendations in the field of teacher education for this important leadership.

Certainly no people in any previous time in history have had challenges of such magnitude before them.

# EDUCATION IN OUR AGE: LET'S DEFINE THE PROBLEM

**GLENN T. SEABORG**, *Professor of Chemistry; and Associate Director, Radiation Laboratory, University of California, Berkeley*

It is an honor and a privilege to be invited here tonight to share with you a few thoughts on science and mathematics education in the public school system. There are a number of abstruse fields in which every man regards himself an authority regardless of his professional qualifications. These fields include architecture, foreign relations, women, and education. A college professor has to be classed with the layman in a discussion of elementary and high school teaching since his contact with the lower reaches of the educational system is limited. By this I do not mean he does not have a warm feeling for his colleagues in the elementary and high schools. Indeed he is often very grateful to his colleagues because any deficiencies in his own students can be attributed not to his own teaching shortcomings but to the poor raw material passed up to him by his predecessors. Some of the changes and suggestions I shall throw out to you today may have flaws in them traceable to my lack of knowledge of the detailed workings of the public school system. However, I hope that my formulation of the problems that have brought us together here today may help to crystallize the steps we need to take.

First, let me review briefly the crucial importance of fundamental science and applied technology in our world today. The importance of the physical scientist in the development of the weapons of war has been well dramatized by the production of jet aircraft, the atomic and hydrogen bomb, the proximity fuse, the earth satellite, and the long-range missile. In general people realize that our peacetime economy is a science-based economy, but the extent to which this is true is comprehended by few. The pace of scientific research development and application in the past two decades is so astonishing that it is hard for us to appreciate fully such a pace.

Science carries on a continuing revolution in agriculture and makes it possible for a steadily declining farm population to produce a greater total output even though our grade-A farm land is being withdrawn for urban or highway use.

In medicine we have seen the development of the sulfa drugs; the antibiotics, such as penicillin, streptomycin, aureomycin; and the sterol derivatives, such as cortisone. We have seen the introduction of the phenomenal Salk polio vaccine, which seems to have drastically reduced the incidence of another dreaded disease. We have seen the development of new drugs for the treatment of mental disease. There are many, many other developments too numerous or too technical to mention. We are aware of a clear necessity to have a much deeper understanding of life processes in the healthy and the pathological individual so that many of the remaining mysteries of disease can be cleared up.

Time allows only a brief recitation of important industrial products and accomplishments: synthetic rubber, plywood, plastics, television, high-fidelity sound reproduction, synthetic adhesives, paints and corrosion-resistant coatings, new methods of printing and reproduction, color photography, titanium, tantalum and zirconium metal, transistors, magnetic tape, solar batteries, electronic computers, nuclear reactors, jet aircraft, atomic powered submarines, and earth satellites.

Each phase of our everyday life, whether it concerns food production, heavy industry, transportation, communication, commerce, entertainment, public health, medicine, home life, or our social behavior, depends very directly on the development of these new products. It is hard to establish in cold dollars and cents what part of our gross national product depends directly or indirectly on the scientific applications that have been developed to commerical usefulness only within the past decade, but it certainly is a substantial per cent.

The new scientific developments that continually flow into our industrial system must continue to come at an accelerated pace if we are to cope with the problems raised by our expanding population. We have been fortunate today in having the population growth situation reviewed for us by Mrs. Aryness Joy Wickens, who gave particular attention to age groupings. The present population of the United States is 168 million, increasing at the rate of 1.5 per cent annually. This means a 35 per cent increase in 20 years and an increase of almost 100 per cent by the year 2000—only 42 years hence. Our electrical power-generating capacity and our entire industrial production base will have to be more than tripled to meet the needs of this large population. Problems of no mean magnitude will arise in food production, conservation of forest products, conservation of depleted mineral supplies, fresh water supplies, waste disposal, urban congestion, public health, transportation services, and the like. At the same time our commitments to improve the technology of less fortunate nations all around the world will require us to export large numbers of technically trained people.

These are challenging problems, and they are made even more complex by the international problems that crowd in on us and that will continue to crowd in on us until they are resolved for us in one big mushroom cloud or until we achieve some kind of international stability. We have the fearful necessity of matching and, if possible, exceeding the Russians in ballistic missiles, earth satellites, space platforms, antimissile missiles, submarine warfare, antisubmarine warfare, and nuclear weapons. We have the overriding necessity of waging peace with the Soviet Union and working out with the Russians a peaceful coexistence evolving to a more general community of interest which they as well as we must fervently desire. We have the problem of understanding and influencing the emergence of the former colonial and backward nations toward new political and economic organization.

What are the main conclusions of this hurried analysis pertinent to our deliberations in our present two-day conference? I think they are the following:

First, the steady development of first-quality scientists and engineers is absolutely essential for national defense and for the health of the national economy. They must be highly trained in the mathematical and conceptual complexities of the fundamentals of their science and have the creative imagination and experimental or theoretical ingenuity necessary to see and exploit new relationships. They must have a high degree of intellectual curiosity. We need these people in such numbers that it is imperative that we correct the gross waste of our present educational system; we must locate students with high intellectual capability, whatever their economic or racial backgrounds, and see that they are properly inspired and trained.

Secondly, we must recognize that a basic knowledge of science is fundamental to good citizenship and effective participation in today's society. We hold to the view that a liberal education is the best preparation for a life of significant achievement and service and that no education can be considered liberal that

does not include science as an integral part. Every phase of everyday living is so inextricably bound up with science that even a person with no inclination for a scientific career is affected directly by science and will find it helpful or essential to have some scientific literacy. Few farmers, army officers, legislators, bankers, or corporation executives can get through a day without making some decisions that would be better made if the decider understood his science better.

Thirdly, our industrial and commercial society requires at all levels an enormous number of technically trained workers and managers with some solid training in science. A large number are required to provide immediate support to the creative scientist or engineer. The creative scientist is being aided these days by complex electronic computors, spectrophotometers, mass spectrometers, ultracentrifuges, electron microscopes, x-ray cameras, particle accelerators, nuclear reactors, and many other complex research tools. It is necessary that much of this equipment be operated and serviced by technically skilled men and women. When this manpower is not available, the more highly trained scientist may be forced to become a slave of his tools with perhaps severe injury to his creative functions.

As factories become more complex the total number of workers per production unit may steadily decrease, but those required need greater intellectual training. Furthermore, the nature of the job will change over the years; the worker needs the adaptability provided by fundamental scientific principles so that he may be of maximum usefulness throughout his career. I am thinking of such people as the oil refinery worker, the chemical plant technician or shift boss, the telephone and communication serviceman, and the electronics technician. Their jobs can be highly interesting and can often lead to positions of considerable responsibility and financial rewards. Our industrial development is greatly hampered and hundreds of millions of our national defense contract money is wasted because we lack technicians whose native intelligence has been developed adequately to handle their jobs efficiently. One of the main props of the American industrial economy has been the large reservoir of literate, intelligent workmen available in this country. But we have not moved sufficiently to meet the needs of the scientific revolution of the past few decades, and the scientific illiteracy of the great bulk of our working population is now causing us grave injury.

The managerial class in American business is being drawn increasingly from the ranks of the technically trained. It is, therefore, a little strange to witness the overcrowding of our collegiate courses in commerce and business administration. I have read that business students comprise the largest single undergraduate group in our colleges—larger in 1955 than the majors in mathematics, in *all* the natural sciences, in *all* the physical sciences, in *all* the biological sciences, and in English, put together. The great aim of this group is to be the personnel men, the executives, and the managers who hire and guide the work of the technical men in our technological business society. Surely there is something grossly out of line here.

My fourth main conclusion from my emphasis of the importance of science in our present civilization is that the general public must become more aware of the ever-increasing importance of scientific knowledge. People must be jarred out of the comfortable complacency that America will always lead the world in science and in commercial productivity and that our standard of living and national security are assured by the system as it stands. Sputnik performed a very

healthy service in chipping a big hole in this myth. It should be our hope to sustain the mood of reappraisal that Sputnik has set. In the field of education we need to start and to sustain those measures that will cause students, parents, and the general public to place good school programs, good teaching, and sustained and rigorous study high among the things they value.

What, then, should we aim for in the elementary and high school curriculum to prepare our youth for this scientific age? First, let me remove a few bogies from the scene. We should *not* aim to make every intelligent American youth into a nuclear physicist. We should *not* engage in an all-out numbers race with the Soviet Union to see who can produce the greater number of engineers. We should *not* make the curriculum so loaded with math and science courses that those who survive the training are lopsided in their development and those who fail are unfit for anything else. We could not achieve such a ludicrous imbalance if we strove to do so and no one is proposing that we should.

What we require as an ideal minimum is that the precollege student take those basic prerequisite studies that will prepare him for the later serious study of science. These studies are arithmetic, mathematics, physics, chemistry, and biological science. It is also important that the student learn reading, English grammar, composition, history, geography, foreign languages, and the other basic academic subjects. In passing, may I say that our foreign language offerings should include Russian. If we put special emphasis on mathematics and science today it is because these subjects have not received the attention a balanced curriculum requires. If you ask an important scientist or a learned professor of law or of the humanities to outline an ideal precollege curriculum, I believe you will get essentially the same master plan. Basically, the problem that faces us today is to add to the quality and quantity of our pool of trained manpower in all fields. I feel that a strengthened precollege curriculum in mathematics and science is just as important for the future lawyer, humanist, or business leader as it is for the future scientist. We may find that some frill courses will be demoted or eliminated in the process. The schools are under constant pressure to give courses in the dangers of alcoholism, in home relations, in conservation, in social adjustment, in dating problems, and so on. These pressures must be resisted to restore the academic studies to their proper place. Accompanying this restoration must be an attempt to convince the student of the necessity for harder work and more serious application to academic studies.

Our high schools are sending about half their graduates to college, and the trend is toward an even higher per cent. Many in this tidal wave of college students will be seeking strictly vocational training. I would guess that somewhere between 30 and 50 per cent of the high school graduates should be intellectually capable of serious advanced courses of study in college. Perhaps those of you who are experienced in evaluating school groups will regard this as somewhat optimistic. For this group I think it is important that the road to a scientific career be kept open until the freshman or sophomore year in college. The high schools should encourage this group *in toto* to arrive at college with sufficient algebra, geometry, chemistry, and physics so that they can enter upon scientific majors if they desire. I think the student below age 18 in general has too little to go on to make a mature choice of career, and he and his counselors should not take him out of the race until his intellectual powers are proved to be inadequate to the effort. In this matter of keeping the gate open until the last possible moment, the mastery of arithmetic and simple algebra and geometry is

of crucial importance. A weak background in chemistry or physics can be overcome, but a weak background in the elements of arithmetic is an almost insuperable difficulty. I shall have more to say about this later.

Let us speak now of some of the defects of our present school system that restrain us from the realization of our educational goals. The all-important part of any school system is the teacher. We can devise the ideal curriculum and build the most modern school building, and in the end we have nothing if we put into that school a poorly qualified teacher. We are fortunate in California in having a substantial number of well-trained and devoted teachers who have brought national renown to a few of our schools. We know also that we have many that are not so good. I don't wish to say much about these; in a society so badly in need of teachers, and in which the financial and personal rewards are so meager, it ill behooves us to criticize severely those willing to serve. We should rather inquire into the factors that keep such an unnaturally high per cent of our science majors and student leaders from even considering a career in teaching.

One obvious problem is the matter of salaries. On a national scale the situation is simply shameful. The average annual wage in elementary schools ranges from $3,000 in small towns to $4,800 in large cities. In high schools the range is $4,000 to $5,500. By contrast, factory workers in principal industries generally get $5,000 or more. Railroad conductors get $6,600. In California standard salary schedules are not so dismal although we can't be proud of them. Starting salaries in most California districts now range from about $4,000 to $4,800 with an average of around $4,400. However, the maximum salaries are only $6,000 to $9,000 with an average value throughout the state of perhaps $7,500. Furthermore, these maximum salaries are achieved only after 11 to 14 years of service and after the accumulation of 60 or so more units of academic credit taken at the teacher's expense in time and money after he graduates from college. Not long ago the night foreman at one of the larger Bay Area high schools approached one of the scientific teachers to reveal that he had a secret wish to become a teacher and to inquire what he would have to go through to be accredited. During the course of the conversation they discussed salaries; the foreman's salary of $6,600 per year was just $1,000 per year greater than the average of all teachers in that large high school. I did not learn whether the chemistry teacher subsequently applied for the job of night foreman!

It is possible to estimate quantitatively how low the salary schedule is, at least for science teachers, by looking at industrial wages for science majors with B. S. degrees. The Personnel Office of the Los Alamos Scientific Laboratory runs a very detailed annual survey on this subject. From this we learn that for all scientists with B. S. degrees in non-supervisory jobs in industry and government laboratories and Atomic Energy Commission contractors, the average of the upper three-fourths salary fraction for the whole country is $5,800 to start, $7,980 after five years, and $10,200 after 15 years. Those who go into supervisory or administrative posts are a larger group, and they are typically earning much more after many years of service. This comparison is at once a source of despair and of hope. It is a source of despair because the difference is so great that if it is not changed, it will continue to deter all but the most devoted science majors from entering a teaching career and staying in it once started. It is a source of hope because the differential is not so great that we could not close it quickly if we took resolute action and enlisted the public's support in making it stick. Specifically, I would recommend that starting salaries be raised

somewhat, but I would jump the maximum salaries immediately by 40 per cent and increase the rate of advancement toward this maximum, particularly after three or four years of reliable service. If we did this, I think we would be in a strong position to entice into teaching more scientists with B. S. degrees. Without such action we shall continue to be frustrated in trying to buy a valuable commodity in a seller's market. One of the secrets of success of the highly publicized Russian school system is the fact that the ranks of the teachers are staffed from the most intelligent of the college graduates, and the teachers hold a position of great prestige and material well-being compared to the general working public. The same is true, of course, in many European countries.

No real reformation of the educational system of the United States is possible without a substantial increase in the prestige and income of the public school teacher. And in our society the two are close to inseparable. If we increase the teacher's income substantially, we automatically do a great deal for his prestige. Some will say we cannot afford all this money for schools; taxes are too high and while it would be nice to increase teachers' salaries and build more schools, it just isn't realistic. Well, it is all a question of values and how you work out your realism. The approximately 100,000 public school teachers in California are underpaid on the average by $1,000 a year at the very minimum. So from this 1 per cent of the state's population we get a whopping 100-million-dollars-a-year subsidy for the education of your child and my child. Is it really true that the rest of us cannot share this burden? Industry spends millions in training programs to prepare workers for effective use in industry. Part of this is done to repair educational deficiencies that would not have appeared in a better school system. Industry does without the ingenious new ideas which the undeveloped intellect fails to produce. I would defy anyone to compute how many hundreds of millions of dollars in American industry today and how many tens of thousands of jobs are directly traceable to the work of Otto Hahn and Enrico Fermi. Money for education is just sensible insurance in a world filled with numerous unknown risks. We are not straining ourselves financially to support our schools and it is just silly to state that we cannot pump more of our income into schools without severe economic strain. As a nation we are spending as much money on smoking and drinking as on education. More money will have to come from the local community, the state, and the Federal government. I am strongly in favor of a much larger Federal aid program than has so far been proposed by the administration. Some have qualms that Federal money is tainted money, but when it comes to education I say 'taint enough. I believe that devices can be found, if we apply some ingenuity, for applying such aid without endangering the proper local control of schools.

The requirements for the teaching credential in the schools of California, as in other states, is a barrier to the enticement of higher-quality personnel into the teaching ranks. This is a hotly debated topic about which you can get angry words and firm conviction on either side. We must have accrediting standards. The prospective teacher has to have some preparation for the not inconsiderable problems that will confront him or her when he or she faces the first class. The elements of judo may be very valuable, for example. The elementary school teacher has to teach a variety of subjects in which she must get training. She handles a growing, developing child about whom she must have some understanding. She must know something of teaching methodology. Above all, she must have some supervised practice teaching. The same things are true, although per-

haps to a lesser extent, for the secondary school teacher, who has to teach a more restricted list of subjects. The big question is how extensive the training in these matters must be before the applicant should be accredited by the State.

A college professor is always struck by the big difference between college and high school practice in this regard. A scientist with a Ph. D. degree can teach on the University of California campuses or at Harvard University without any teaching training at all. Sometimes this is a big mistake. But the educational system at the University of California and at Harvard does seem to attract high caliber staff members and to produce high caliber graduates. Nevertheless, these same men with Ph. D. degrees would be forbidden to teach in the high schools of this state. What is particularly striking is that they would be forbidden to teach in the junior colleges of California. I would immediately abolish *all* education-course requirements for junior college teaching for candidates with advanced degrees in major academic subjects. Otherwise we effectively bar scholars from enriching our junior college program.

A student who gets his B.A. or B.S. degree before deciding to go into teaching faces an uphill climb through about three semesters of educational courses before he can get his credential. In the meantime the one who holds a B.S. degree in science can accept an industrial job for $450-500 per month, and after 18 months his pay will have risen to $500-525 before the time he would have started work on a $400-a-month teaching job. So naturally he says "to heck with teaching!" I think the required courses in educational units are too many and I should like to see the State accreditation board reduce them quite substantially for people with the B.A. or B.S. in mathematics and science. We have a real dilemma here. On the one hand, we know that the teacher is benefited by some training in child psychology, child development, and teaching methodology. I have talked to enough professional education specialists to be convinced of the truth of this. On the other hand, we have a severe shortage of high school science teachers, and by insisting that only teachers accredited by present standards be permitted in the classroom we have to convert zoologists, botanists, and perhaps even physical education majors into physics teachers. I submit that all the methodology and educational psychology in the world won't cover up the teachers' glaring deficiencies in physics. Remember that this teacher's physics may have to come from what he can remember of his high school course.

My answer to the dilemma is this: As long as we have a teacher shortage in the vital high school subjects of mathematics and science, I would try to lure promising seniors with majors in these fields into teaching. Those with an A or B average could enter the classroom with a temporary credential after the bare minimum of practice teaching. If these teachers succeed in doing two years of teaching judged satisfactory by the school district, I would give them permanent credentials. In Texas a graduate holding a bachelor's degree may receive a temporary certificate good for as long as four years after taking only six units in education methodology, which may be taken over television. We shouldn't allow the Texans to hold this advantage over us. Inspiration by a teacher is one of the most important factors in motivating a youngster toward a scientific career, and in high school this is usually done only by the teacher who is trained in, knows, and loves his subject.

I think the expert who could give us the real answer on this point is the practicing teacher—*not* the outside critics, *not* the professional educator or administrator—but the classroom teacher with several years' experience.

The School of Education at the University of California, Berkeley, has started a very sensible program that can get a man with a B.A. or B.S. degree into the classroom within a few months. The department operates a laboratory high school in Oakland during the summer. The embryonic teacher participates in practice teaching there during the summer and simultaneously takes education courses. In the fall he can accept a regular teaching job within 50 miles of the campus. During the year he takes some course work after school hours. During the next summer he completes his formal requirements for certification. This is a good program, worthy of extension. A peculiar advantage of it is that the people attracted into it are much better trained in the end and 100 per cent of them go into teaching, contrasted to the 50 per cent of students who complete the requirements for the regular credentital and *never* go into teaching.

Since no program we can start today will fill our classrooms with highly competent teachers this fall or for many falls to come, we have to do what we can to retrain and encourage those we have. Traditionally, the teacher goes back to school in the summer at his own expense to pile up more credits. This interferes with his chance of earning additional income in the summer. Too often the summer retraining is not very purposeful. If the teacher is a zoology major who wants to brush up in chemistry because that is what he is teaching, he will probably find no course that is pitched at the rather elementary level which he needs, and gives college credits, which he also needs. So he takes some more units in education instead. This is deplorable, and the universities and colleges must share the blame here. I think that this should be remedied by appropriate action in the colleges and universities. Another measure the universities could adopt would be to offer an M.S. degree in a unified group of sciences, such as algebra, chemistry, and physics, for high school teachers who have to teach all three but do not need to go deeply into any one.

Recently we have had many special summer science training programs for high school teachers, combining the desirable feature of pay, credit, and subject-matter review for the teacher. The Radiation Laboratory has run one for 25 or so selected high school science teachers for the past three years, using A.E.C. funds. The University ran one on the Berkeley campus with support from the National Science Foundation for 200 teachers last summer. The National Science Foundation may be expected to have much larger budgets for such programs this summer and next, and the educational institutions of California should be energetic in the submission of proposals for the extension of this highly desirable effort. The refresher course is very helpful to the teacher. It is also a stimulating endeavor for the professional scientists who run the programs. For too many decades there has been an almost total lack of contact between the college and high school science teachers. The most valuable part of the program at the Radiation Laboratory was the lab work, which gave the teachers a good idea of how the research scientists went about their work.

In many ways closer contact between the high school science teacher and the professional mathematician or scientist is of great value and should be encouraged. I know that interest in educational matters is very high today among professional people and that many would be willing to give help to high school teachers or to intelligent high school students. This contact is not always easy to establish, due to the uneasiness of the teacher or to other factors. The Bay Area section of the American Chemical Society has been doing some interesting and effective work of this kind.

I should like now to say a few words about the special importance of mathematics. Command of mathematics is absolutely essential for any serious work in the physical sciences and engineering. It is highly desirable that algebra and plane geometry be taken in the ninth and tenth grades or even earlier, so that capable students can go on to trigonometry, advanced algebra, solid geometry, and even elementary calculus and analytical geometry. Most scientists today would recommend replacing solid geometry with elementary calculus when only one can be offered. Mastery of these subjects is highly important, yet we find that many of our college freshmen are unable to use their earlier training in very simple algebra. A great deal of this trouble has to be traced back to the elementary school. The inspiration and guidance of enthusiastic teachers does more to interest pupils in science and mathematics than anything else does. Many persons who have studied the motivation of children have concluded that the success or failure of the elementary school teacher in captivating the child's natural interest in numbers and laying a firm understanding of the principles of simple arithmetic is of crucial importance. I have recently discussed this matter with a nationally recognized authority in elementary school arithmetic who is absolutely convinced that the arithmetic training of the child through the first five grades pretty well determines for life what his interest and facility in mathematics and hence in science can later become.

Do we have inspiring teachers of arithmetic? We may have some, but even in California the average teacher's requirements and qualifications for teaching arithmetic are close to zero if not altogether negative. In the great majority of cases the elementary school teacher never learned arithmetic thoroughly, does not understand the principles involved, disliked and still dislikes the subject, and manages, not surprisingly, to pass on her distaste to her pupils. The results are shattering! A simple test in scholastic aptitude was composed for use by the United States Army in its World War II draft deferment program by the Educational Testing Service. Of students majoring in education, no more than about 27 per cent were able to make passing grades. The elementary school teacher has a very difficult task. She has to teach every subject to her classes; she must know reading, art, music, social studies, spelling, English, health, and other subjects as well as arithmetic. It is a miracle when mathematics is found to be one of her strong interests. The teaching of arithmetic by a person not interested in the subject will remain on the level of mechanical manipulation of figures. This is a very tough problem and one that may take a generation or more to solve.

A few suggestions might be of value: Let us provide for the retraining of the elementary school teacher in arithmetic by programs in which she gets extra pay and credit for her effort. Formal summer programs jointly financed by the National Science Foundation and State institutions of higher learning similar to the high school science teacher retraining program would be desirable. I strongly suggest that State institutions in California set up such programs. The teacher would receive a weekly stipend and something toward her travel and extra living expenses. Generous fellowships should be available to individuals for regular university summer course work. The qualifications for such fellowships should simply be that the individual is regularly employed in a California school district and is able to obtain admittance to the college. Representatives Melvin Price and James Van Zandt have recently introduced a bill in Congress providing for a $500 fellowship to any high school senior who can pass an examination of prescribed

difficulty in mathematics. It is an excellent suggestion. A similar program for elementary school teachers would stimulate interest in home study of mathematics. It might take the form of an offer of a cash prize and a certificate to any elementary school teacher who passes an arithmetic and algebra examination of prescribed difficulty.

The larger elementary schools might consider the use of special arithmetic teachers or, if a certain teacher on a school staff is much better in arithmetic than her fellow teachers, she might handle several classes and release her own classes when the art or physical education period comes up. Many school districts employ roving supervisors in special subjects such as arts and crafts. These supervisors check up on the teaching in all the schools and provide suggestions and new ideas and techniques to the teachers. I propose that arithmetic and science supervisors be introduced to perform the same functions in these fields. I have placed emphasis on the teaching of arithmetic where the emphasis belongs. But we should certainly start the teaching of science as early as the first grade, also.

Many of our schools have excellent after-school, Saturday, or summer-holiday programs in arts and crafts, foreign languages, music, and dancing for the elementary school children. These programs often are self-supporting through the collection of modest tuition fees, and the people from the community who serve as teachers are often remarkably gifted in stimulating the interest and development of children. Why should such programs not be started in arithmetic and science, particularly in the large cities where many professional people reside? It might take a little fumbling to identify the good teachers among the interested professional people and to work out a realistic program, but there is absolutely no reason why it shouldn't work.

At some point in the school system we need to make some provision for the widely different levels of ability of the students. We should meet the needs of the retarded student, but the exceptional student should also have special encouragement. I think we must declare once and for all that special attention to the needs of the superior student is not antidemocratic as long as any student, whatever his religious, economic, or racial background, is permitted to join the select group when his school achievement earns him that consideration. It is deadly to the motivation of the top 20 or even the top 50 per cent to have the class proceed, year after year, at the pace of the slowest members of the class. Several experiments are going on in the United States that we should study for possible application in California. I wish our California school districts, particularly in the large metropolitan areas, would try a variety of experiments, for I think it will be hard to know in advance whether a separate high school for superior students, separate classes for superior students, self-study for superior students, or some other system or combination of approaches will work out best.

I think also that the professional members of the community are willing and eager to help out in the counseling and perhaps even in the instruction of the superior student. Such persons can make clear to a youngster the prerequisites, the nature, and the rewards of a professional career in a way that is usually impossible to the teacher himself. Such persons could serve as part-time tutors to superior students undertaking a home study course in, say, calculus when no such course is offered in the youngster's school.

There certainly is room for improvement in the textbooks that are in use in our schools although many of them are very good. As an example of a deficiency in this area, a group of physicists centered at the Massachusetts Institute of

Technology made a study of the 14 leading texts in high school physics and found that they were all unsatisfactory in one way or another. A committee is hard at work on the preparation of a satisfactory textbook of physics for broad use throughout our country's high schools. Perhaps similar programs should be undertaken in other fields such as chemistry.

I believe that we should continue to explore the roles of television, moving pictures, and audio-visual aids for instruction purposes. I find that among teachers in general such experiments are discounted, and their objections to the materials now available are often sound. But I have the feeling that the little difficulties that could be eliminated by closer co-operation between the producers and the teachers are getting in the way of success. Are the 50-minute installments of Harvey White's TV-movie physics course too long for some class periods? — Well, get them remade in 15- to 20-minute installments if that is the answer. Do Professor Seaborg's science films cram too much into one show? — Get someone to bring him down to earth and convince him what the realistic content of a single show should be. Let us not give up on these technical devices that are fundamentally such powerful aids to instruction. I think it would be wise for the State Legislature to appropriate money for the support of educational TV experiments.

There are many important activities of organizations like the National Science Teachers Association, the California Science Teachers Association, and the Elementary School Science Association, but my limited time does not permit me to describe their work. I am also favorably impressed by the programs of awards to outstanding science teachers and to outstanding students, the use of traveling libraries and traveling science demonstration laboratories, Science Talent Searches, and the Science Fairs. I would like to suggest that the Science Fair principle be further extended to include representatives from the grade schools as it has from some other sources.

I believe no review on educational problems in California would be complete without a few words on the special problems of the minority elements in our population. Some students come into our schools with such severe handicaps generated by poor family background and poor elementary schooling that it seems hopeless to do much for them other than to provide some sort of vocational training. But native intelligence is not a special monopoly of the white race, and we must not overlook the potential Enrico Fermis among our Mexican, Negro, and Oriental ethnic groups. The problem of motivation is especially critical here. It is true that parents of Negro and Mexican-American children are not much in contact with the intellectual occupations and do not ordinarily encourage their children in academic subjects beyond the three R's. They often find it beyond their comprehension that an intellectually based education and future occupation have any possible relevance for their children. The irony of this is that the monetary rewards and job security accruing to the well-trained person from a minority group are substantial. It is true that the Negro professional worker is subject to considerable job discrimination, but the pattern of this is changing fast and the discrimination at the level of professional work in the sciences is much less than it is in the unskilled occupations. I am greatly encouraged to see how many of the young generation of Japanese- and Chinese-Americans have become highly trained in electronics and electrical engineering and in the sciences in general. The example of the brilliant Lee and Yang who shared the last Nobel prize in physics will also certainly have its inspirational effect among the Oriental population. I think we should stress more strongly the importance not only to the individual, but to the State of Cali-

fornia, of the education of the Negro and the Mexican-American. We need the aid of the teacher in identifying individuals of superior intelligence. We need a more organized effort on the part of the community to support and encourage such intelligent youngsters when they are found. It is hard for most of us to look at a young person of any race, of rather unprepossessing appearance, and think of him as a man of potential mathematical genius, or a future contributor to cancer research, but we should steadily remind ourselves that there is a statistical certainty that such persons are appearing in all racial groups every year.

Well, I have covered a lot of ground and I have not once mentioned the nuclear fission of uranium or the production of synthetic transuranium elements. This is a pity, because I am supposed to be an expert in those subjects and you could go away feeling you had learned something that you could accept as truth from a real authority. Maybe you will seriously question the correctness of my layman's suggestions for science and mathematics training in the schools of California. But if I have stirred up some serious thought and convinced you of the seriousness of the problem, I shall feel satisfied.

## REPORTS AND RECOMMENDATIONS OF SECTION MEETINGS OF THE CONFERENCE

The general purpose of the 10 section meetings held during the second morning of the conference was to provide opportunity for all participants to discuss the two general questions that follow:

1. To what extent is the present instructional program of the public schools meeting the needs of the State and the nation for persons with competency in science and mathematics?
2. What specific proposals should be made to increase the effectiveness of the school program?

Participants in the section meetings were also encouraged to consider specific questions of the type that follows:

1. What needs in our state and nation have been identified that emphasize the importance of manpower that is highly proficient in science and mathematics? How can it be determined in what fields such personnel are needed and how many in each field?
2. Is there evidence that the manpower of California as well as that of the nation needs greater proficiency in science and mathematics than it now has, and does the evidence also show need for more manpower with such proficiency?
3. If there is evidence that California's manpower and that of the nation need increased proficiency in science and mathematics or need to be increased in number, what action should be taken by the public schools to meet this need?
4. What action should be taken to help the public schools develop and maintain an instructional program that is adequate to meet current needs and is sufficiently forward-looking to meet new needs as they arise?

The material that follows consists of the reports and recommendations of the 10 section meetings.

### Section One

Frank A. MacDonald, *Chairman;* Dan T. Dawson, *Recorder*

The public schools of California have done a creditable job of instruction in the areas of science and mathematics. The objective of this conference is to help them do an even more satisfactory job.

While the great urgency of the times is recognized, a "crash program" might be unnecessarily damaging to our system of education.

#### *Recommendations*

A careful study of the science and mathematics offerings in California public schools should be made with reference to the total needs of a balanced educational program. This study should be made by a joint interim committee of the Legislature.

It is suggested that the interim committee give consideration to subjects such as the following:

Advisability of mandated courses
Special in-service training programs for teachers at all levels
Length and organization of the school day and year

Counseling programs
Extent to which textbooks should be furnished by the state
Incentive pay for teachers
Services of special consultants in arithmetics, mathematics, and science
Training programs for prospective technicians
Responsibility of local groups in programs set up to improve science and mathematics curriculums

It is obvious that the adequacy of the program will also be affected by the nature of the school district organization, the school buildings and facilities available, the total school enrollment, the enrollment in science and mathematics classes, and the availability of needed teaching personnel.

SECTION TWO
Roy Rosenberg, *Chairman;* Ernest Campbell, *Recorder*

In our times a large portion of human knowledge is in the physical sciences and life sciences. Today's world is a highly technical one, and the world for which today's students are being prepared will be even more technical. Any school curriculum, therefore, that does not include instruction in basic science and mathematics may no longer be considered well balanced.

*Recommendations*

Science and mathematics instruction should be included in the curriculum at every grade level in the elementary school.

The preparation of elementary school teachers in the areas of science and mathematics is not adequate. In-service education programs, therefore, should be established to improve the competence of teachers in these areas.

Secondary school programs should include science and mathematics for all. The science and mathematics programs should be designed so that students with various goals can secure the help they need. The design should make provisions for each of the following:

1. Meeting the needs of the ablest students—those who will follow careers in which science and mathematics are important tools, and those who will take up careers that are almost wholly absorbed in science and mathematics.
2. Meeting the needs of those whose interests are leading them to make career choices in other fields but who desire a good background in science and mathematics for cultural balance.
3. Meeting the needs of those who want to have some understanding of the expanding world of science and mathematics but whose primary need is for practical scientific and mathematical knowledge and the ability to apply it to basic situations in everyday life.

The California State Board of Education should recommend, to local school districts, minimum standards for curriculum requirements and for performance in all fields, including science and mathematics.

Teachers who can motivate and inspire students are needed in much larger numbers. To secure such teachers, added incentives are needed for those who are preparing to become teachers to develop the skills, attitudes, and knowledge required. The quality of our educational program is dependent to a very great extent upon the quality of our teachers.

The attraction and retention of good teachers is one of our basic problems. The public must be made aware of the skills, qualities, and abilities essential to

good teaching and must be led to reward competency in the teaching profession through recognition, honors, and remuneration.

Local school districts must evaluate their programs to make certain that (1) there is a sufficiency of courses in their schools to meet the needs of the students; (2) the content of each course is adequate; (3) the courses are competently taught; and (4) the standards set for student performance are sufficiently high. Students must be so counseled that they select courses with subject matter that is conducive to meeting the requirements of modern society.

In expanding the supply of trained scientists and engineers, the nation needs to take advantage of the possibility of getting more women to specialize in these fields. (Only 62 of the total of 22,589 bachelor's degrees in engineering conferred in the United States in 1954-55, went to women.)

SECTION THREE

Mrs. Russell Scott, *Chairman;* Jackson Price, *Recorder*

The need for better trained teachers in science and mathematics is serious, as is the concomitant need for improving the over-all instructional program in these areas. Immediate efforts to meet these needs must involve teacher recruitment and in-service training.

Throughout the nation there is a great need for genuine respect for and recognition of high scholarship. Steps should be taken to secure both.

Identification of scholastic and vocational interests and aptitudes at an early age is highly important. Of equal importance is the effective motivation of children and youth in the educational processes.

More flexible programs of education are needed for gifted children and youth. Such programs should be established as soon as possible.

The nation's manpower needs should be dramatized to help youth prepare for future competition and to stimulate in youth an awareness of the acute demand for qualified persons in jobs calling for scientific training and mathematical skills.

Science textbooks now under consideration for state adoption can help provide a richer program of science instruction in the elementary schools of California.

*Recommendations*

To improve science and mathematics instruction in the schools, our educational leadership must, without delay, (1) require more in-service training for teachers already in the classroom; and (2) recruit a high caliber of personnel to train for the teaching profession.

Teachers should not be expected to take in-service training at their own expense. School district funds, scholarships, and other kinds of financial help should be used for this purpose. So long as teachers must bear their own expenses for such training, however, they should be entitled to deduct these expenses from their income tax returns.

Every effort should be made to improve the social and economic status of teachers. Pay scales should be raised to equitable levels so that competent men and women will not have to leave teaching for better paying jobs.

A greater number and a better quality of counseling services should be provided in California elementary and secondary schools. Efforts should be made to increase state financial support to make augmented and improved services possible.

Steps should be taken to obtain special state subsidies for educating gifted children and youth, in amounts equal or comparable to those provided for other

groups needing special attention. Practical measures should be adopted to ensure that gifted young people, particularly those who show preferences for science and mathematics, are given ample opportunity to develop their potential to the fullest extent so that they can complete academic programs that are best suited to their needs, abilities, and rates of progress.

One or more summer camps might be established and supported by foundations, by the state, or jointly, to enable qualified students to continue their exploration of science during summer vacations. A stipend could be provided for each student attending.

Efforts should be made to interest foundations and other agencies in (1) providing funds that would permit institutes with noteworthy teaching techniques to send out specialists to lead regional workshops for teachers; (2) providing scholarships for teachers attending these workshops; and (3) subsidizing universities that undertake programs in which scientists, mathematicians, and educators are brought together to develop new or revised textbooks and courses of study in the areas of science and mathematics.

Teachers should be allowed full credit by their school districts with reference to salary schedule placement, and by colleges and universities in the matter of meeting credential qualifications, for courses taken in their subject-matter specialization areas, even though the courses carry only lower-division credits.

SECTION FOUR

L. C. Van Atta, *Chairman;* Henry T. Tyler, *Recorder*

A number of recent studies have listed specific needs of the state and the nation for scientists and engineers, and for teachers as well, and have estimated the numbers of such personnel that would be required. There have been disagreements over the estimates given, but it is generally agreed that we are moving rapidly toward greater utilization of science and technology. This led to the following statement of needs:

1. Everyone should be required to achieve a basic level of understanding of science and mathematics.
2. College preparatory courses should be of such nature that those who complete them are sufficiently well prepared to choose majors in science or engineering.
3. The intellectual challenge of science and mathematics should be offered as a stimulant to gifted students.

The section agreed that the nation as a whole does not have a sufficiency of outstanding teachers, scientists, engineers, technicians, and instrument makers; and felt that possibly the nation never will have a sufficiency of these. The section proposed, therefore, that emphasis be placed on quality of training for such personnel rather than on the quantity of personnel.

The group then briefly examined an extensive list of suggestions made by the conference speakers during the first day—suggestions bearing directly on numbers 3 and 4 of the specific questions listed on page 351. The remainder of the discussion period was taken up in exploring facets of the question: "What should be done by the schools?" Recommendations pertinent to this question follow.

*Recommendations*

Increased continuity of science and mathematics instruction throughout the school year is desirable, with a widely differentiated program of mathematics for all high school students. Quality grouping in this relationship is important.

A careful review of the entire curriculum, especially that of high schools, should be in order. This may lead to eliminating some of the many subjects now required by legislative enactment, or relegating them to summer programs, in favor of giving more time to hard core subjects, including science, mathematics, the humanities, and social studies.

Less emphasis on competitive athletics would result in greater attention being given to a program of physical fitness for all, and would save both time and money for other uses that are more important.

Greater flexibility in teacher certification is advocated to aid in relieving teacher shortages. Greater emphasis on subject matter preparation and less on the taking of education courses is believed desirable. It is suggested that certification might be abolished for junior college teachers.

Credits earned in taking college courses for which graduate credit is not given should be counted toward salary increases where such increases depend upon additional credits earned, provided that the courses are needed by the teacher in carrying out his regular assignment.

Greater use of the wide variety of teaching aids now available is advocated. This would include greatly increased use of educational television, films, science models, and the like, although it is recognized that such usage is related to the financial resources available. In this connection, increased service from the State Department of Education in critical reviews of TV materials, films, and other aids for the purpose of advising school districts concerning them would be of considerable advantage.

Greater financial support for schools and increased salaries for school personnel are considered essential. The provision of reimbursement and salary incentives for upgrading teachers in their subject competencies is much to be desired.

SECTION FIVE

Oscar Menenga, *Chairman;* Bruce Miller, *Recorder*

The first part of the meeting concerned the important issues of teacher shortages, competencies and weaknesses in the teaching profession, evaluation of teacher training programs, and how teaching in general can be upgraded.

Considerable discussion was then devoted to the general area of improving the quality of teaching in the classroom by the incentive of merit pay increases. It was noted that often a superior teacher leaves the school system to enter industry because no financial incentive is provided.

A third area of discussion had to do with counseling and guidance programs in the schools.

*Recommendations*

The number of formal education courses in teacher training programs should be reduced.

Greater attention should be given to emphasis on subject matter in the secondary school. Every teacher should have at least a college major in the subject he is assigned to teach.

In-service training programs for teachers should be strengthened throughout the state. It is possible that many education courses that are now prerequisites for a teaching credential could be covered by in-service training.

Credential requirements for secondary school teachers should be re-evaluated, with broader emphasis on courses in subject-matter fields.

Continued attention must be given to the study of improving teaching quality through higher pay scales and more adequate pay increases. The California School Trustees Association and other groups throughout the state who are concerned with this problem should be encouraged in their efforts to find solutions for it. Industry should be approached and asked to consider the problem co-operatively with school personnel.

Continued efforts should be made to strengthen the counseling and guidance program at all levels of education. To accomplish this will take a considerable amount of additional funds, which will need to be raised by the state and by local communities. Although the current emphasis is on an improved program for science and mathematics instruction, the importance of English, foreign languages, and other solid courses that are essential to modern education must not be forgotten.

SECTION SIX

Philip Sorenson, *Chairman;* Robert Cralle, *Recorder*

To the extent that practical programs of action were developed around specific problems and were related to particular geographic regions, the section members felt that this conference was a success. They also felt that the true worth of a conference of this kind must be judged in terms of the follow-up activities it generates and therefore submitted this appeal: *Don't let the conference deliberations die at this point.* Earlier conferences came to mind—for example, the Governer's Council on Education, in 1955. What was the follow-up to many of the issues discussed at that conference? It may have been worth while to have had summary reports of suggestions and decisions that were made and actions that were taken in the 1955 conference, as well as activities that went on subsequent to it, to give perspective to certain of the problems that have been raised at the present conference on science and mathematics.

Section members felt that we must recognize the dangers of excessive pressure to propel students toward concentrations in science and mathematics course work. While we accept the fact that there is a general need for greater scientific literacy, we should not fail to recognize that manpower needs at the subprofessional levels are even greater than those at the professional and high skill levels. While we do not deny the need for quality of performance, creativeness, imagination, and the like, in areas related to science and mathematics, we should not overlook the same or similar needs in others areas of education, such as the social studies and the humanities. Nor should we minimize the importance of co-ordinating all of these areas in a total curricular pattern that is meaningful and well balanced.

Scientific literacy begins at the elementary school level. Both the schools and the citizenry have the obligation to make available the best possible instruction. This obligation implies continuous attention to the provision of instructional materials, preservice and in-service preparation of teachers, studies of the relative effectiveness of various methods of approach in educating children and youth, and the promotion of school and community interaction that is more effective than it has been in the past.

The State Department of Education has an obligation to equalize situations among school districts where important differences in quantity and quality exist. An example is the textbook situation at the secondary school level, where the ability to provide texts and instructional materials varies widely from district to district.

In-service training of teachers would be made realistic if colleges and universities would provide summer school courses in areas consistent with what the teacher needs and wants. These probably need to be identified as graduate courses to fulfill the requirements demanded by school boards, and specified in salary structures. School boards can make their salary promotion and upgrading policies more realistic by making it possible for teachers to continue their studies without financial worry.

Our efforts to improve the in-service training program for teachers must be equaled by our efforts to improve the preservice training program, particularly in the areas of science and mathematics preparation.

We must recognize the fact that schools cannot outpace their public. Nevertheless there is a great need for solid, energetic research to find ways to bring about greater interaction between the public and the schools.

We must admit that because of teacher shortages, demands upon teachers are sometimes too heavy. We must accept the fact that the quality of education depends upon the quality of work the teacher does in his profession; and we must find ways to recompense the overburdened teacher, such as through increased financial rewards.

The following topics and problems were also discussed: identification of student talent; science studies in the primary grades; the use of laboratories in science teaching; publicity for science and mathematics programs; financing augmented science and mathematics programs; teacher loads in science classes; and continuity of conferences for the future.

The section recognized that no forward steps in the improvement of our educational system can be taken without public support.

*Recommendations*

Attempts to pressure students into science and engineering careers should be discouraged. Students with aptitudes and talents for such careers should be led, through guidance and counseling, to make the choices that are best for them. Meanwhile, there should be greater emphasis upon helping all students to become more literate in the areas of science and mathematics.

Increased attention should be given to vocational guidance, with special reference to the needs of society; and more time for counseling services in secondary schools and in colleges should be provided.

It is suggested that more state aid be extended to local school districts in acquiring textbooks and other teaching materials related to science study in the primary grades.

Superintendents of schools and boards of education should adjust salary schedules so that credit is allowed for undergraduate courses taken by teachers serving under their jurisdiction, provided that the content of such courses relates to the needs of those taking them.

Attendance at science workshops in the summer months should be encouraged by paying salaries equivalent to those they receive in their regular teaching positions to teachers who attend.

The provision of student scholarships should be encouraged. Additional funds for this purpose should be supplied by the state rather than by industry or by the federal government.

The suggestions on keeping the public informed, as included in the 1955 report of the Governor's Conference on Education, are recommended for study.

It is suggested that an examination be made of the present teacher load in science with a view to allowing more time for adequate preparation by persons teaching in the science area.

Research regarding the benefits of using laboratories in science teaching as compared with the benefits of using the demonstration method should be re-examined.

In the areas of science and mathematics, an expanded program in classroom instruction, in the preparation of teachers, and in-service training for teachers will require increased state financial support. This problem should be carefully studied.

During the ensuing school year, the State Department of Education should direct regional conferences on the main problems studied in this conference. A second state-wide conference should be held in 1959, to receive and discuss progress reports.

SECTION SEVEN

I. W. Walling, *Chairman;* Albert Graves, *Recorder*

Significant problems brought out in the conference sessions were discussed, and some of the major recommendations made by the session speakers were evaluated. In the light of state and national needs, the members felt that special emphasis should be given to the counseling and guidance program in the public schools.

*Recommendations*

Every effort should be made by the school districts of the state to expand the guidance program in the public schools by (1) extending the guidance program through the junior high school; (2) promoting and improving the training of counselors; (3) increasing the number of counselors; and (4) establishing guidance programs that would identify those students who can profit by advanced education in science and mathematics.

In order to implement the expanding guidance program, school districts should (1) expand their offerings in science and mathematics for able students in these areas; and (2) extend the school day and school year to provide more time for study in areas where there is need for additional knowledge and research.

SECTION EIGHT

George A. Reynolds, *Chairman;* Arthur Hall, *Recorder*

Although significant improvements have been made in recent years in the areas of science and mathematics training at all levels of education—elementary, high school, junior college, and college—we are not wholly meeting the needs of the state and the nation. Considerable augmentation in these areas is required to meet the needs of our continuously accelerating technical economy.

In solving the problems at hand, however, we regard a "crash program" as unwise. A carefully planned approach will have better results.

*Recommendations*

In view of California's elementary school curriculum requirements, which are highly specific in many areas but not in science, we urge that a comprehensive study be made of these requirements with a view to placing science on an equal footing with other major areas of knowledge.

Homework should be required by the schools, and the schools should provide time during the school day for the student to do a portion of this work; further, the home should provide an atmosphere conducive to study.

A special study of California high schools should be made with the view to reorganizing the high school curriculum in science and mathematics.

Many teachers of science and mathematics should have better preparation in these fields.

Although efforts to identify good teachers have been made, we must continue and increase our efforts in this direction. Whenever competent teachers are identified, they should be rewarded with merit pay increases.

We must identify, encourage, and reward proficient students and provide them with an enriched curriculum. If it is deemed appropriate to do so, we should accelerate their progress in science and mathematics and request colleges to recognize work they have done beyond standard high school curriculum requirements.

Much greater emphasis should be placed on in-service training of teachers who are in need of further academic training. This service should be made available to all teachers at all levels.

Counseling services in junior high schools and senior high schools should be improved so that all students with ability in science and mathematics can be well advised on the educational programs related to these areas, can be guided into areas best suited to their needs and abilities, and can be helped to recognize the career possibilities in scientific, mathematical, and technological fields.

SECTION NINE

Sheldon Campbell, *Chairman;* Bernard J. Lonsdale, *Recorder*

The group gave particular attention to providing on-the-job teachers with training services in the areas of science and mathematics where such services are needed; revising elementary and secondary credential requirements to include solid course work in science and mathematics; making maximum use of public school facilities throughout the state; and taking steps to reward and otherwise compensate teachers for merit in their profession.

*Recommendations*

Twelve units of science, distributed between the physical and biological sciences, should be required for an elementary teaching credential. At least one of the biological sciences and one of the physical sciences should be given as a laboratory course.

The State Department of Education should undertake an immediate study of the competencies and needs of elementary school teachers in the areas of science and mathematics and provide services in the areas that require strengthening.

All those who wish to become candidates for the elementary credential should be required to demonstrate competence in eighth-grade arithmetic as based on tenth-grade norms before being permitted to enter teacher training programs.

For students seeking the elementary credential, a course in the meaning of numbers, given by a college mathematics department, should be substituted for the present course in methods.

As a first step toward maximum utilization of school facilities, the State Department of Education should make an intensive study of current scheduling, hours of attendance, days of attendance, school plant design, optimum student body size, and maximum utilization of school plant, per day and per year.

Students in teacher training for the secondary credential in either physical or biological sciences should have at least 45 units of science courses or, in the case of physical science, the equivalent in applicable engineering courses taken in lower-

and upper-division college work. Further, mathematics should be strongly recommended as a minor for students majoring in physical sciences.

Teachers' wages and the prestige of the teaching profession should be raised in recognition of the fact that teachers contribute services at least equivalent to those performed by their professional counterparts in private industry. Merit should be regarded as an important factor in determining retention, promotion, and pay increases for teachers.

SECTION TEN

R. B. Hinman, *Chairman;* Donald E. Kitch, *Recorder*

Issues considered by the section members as particularly important included the bolstering of in-service teacher training in science and mathematics; reduction of class size; making the most efficient use of teachers; recognizing and providing for the differing needs of youth; methods of learning; specialization of secondary school teachers; school-community relationships; and the roles of science and mathematics in the school curriculum.

*Recommendations*

In-service training of teachers in the presentation of science and mathematics subjects at both the elementary and secondary levels should be increased and strengthened. Such training would give science and mathematics teachers feelings of competency and self-confidence in their work, security in their roles as teachers, and appreciation of the importance of the subjects they teach.

The number of children assigned per teacher should be reduced so that each child can be given the individual attention he needs. Ideally, the number should not exceed 25.

The best possible use should be made of teachers. As one example, closed-circuit television programs should use the services of teachers who are especially facile in classroom presentation.

School administrative staffs should make every effort to remove conditions that hinder teachers in their instructional work. Nonteaching activities such as clerical duties, tasks that are purely administrative, technicians' tests, child care, and the like, should be eliminated wherever possible. Likewise, administrators should do all they can to enable teachers to teach effectively—for example, provide classroom facilities that are adequate, make useful audio-visual aids available, and ensure that special school and community services are readily accessible.

The doctrine of equality of educational opportunity needs to be re-examined. Equality of education should not connote uniformity of education. Intellectual differences among students should be recognized, and differing needs should be met through differentiated educational programs.

Greater attention should be given to the guidance program in the schools to ensure that adequate and effective guidance procedures are being used.

In methods of learning, the emphasis should be placed on reasoning and on problem solving, rather than on rote learning. Teaching the "why" behind the "how" promotes creative thinking. Information without understanding is incomplete knowledge.

Wherever possible, secondary school facilities should be so developed that teachers can be assigned classes in their specialized fields rather than in several fields where they have had little or no training. In the lattter situation many teachers lack both preparation and interest.

Communication between the schools and the general public should be improved. Where it is feasible, a trained public relations worker should belong to the district staff. If it is not feasible, this activity should be assigned to an available staff member who can best handle the job.

Science and mathematics should be given a greater share in the school curriculum, but not to the point of imbalance. The total curriculum should be well balanced and well co-ordinated. At the elementary level, science should be integrated with other subjects in such a manner as to reinforce the fundamentals of learning.

## SUMMARY OF CONFERENCE ACHIEVEMENTS

**C. C. TRILLINGHAM, *Los Angeles County Superintendent of Schools***

A friend of mine from southern California said to me this noon, "You know, I'm really glad I came to this conference. These are big problems we face. When I came here, I was really confused." I asked him, "You mean you aren't still confused?" "Oh, yes," he answered, "I'm still confused, but at a much higher level." Perhaps that's the way we all are. I want to confess my feeling of inadequacy in attempting to report some of the achievements of this conference.

It is neither possible nor desirable to summarize even the highlights of the two days of presentations and discussions. Just now you heard a variety of conclusions and proposals that came from the ten section meetings. Those of you who have had a similar experience know the pressure that these people have been under during the noon period, trying to digest their lunches while they were preparing their materials to be typed for presentation at the two o'clock session. I understand that the reports will be made available in typed form for analysis and further consideration. I can't see any reason why I should repeat in my own words what has just been said to you in an outstanding way. I shall, however, try to underscore some of the major understandings and gains that have come out of this conference.

It is probably human nature to hear what you want to believe and to connect your own hopes and fears with what you hear. I think this has been a history-making conference. As you know, Americans everywhere have been trying to get into the act since Sputnik—Congress, the military, scientists, educators, and the general citizenry. As far as I know, this is the first attempt at the State level to bring together leaders from industry, commerce, labor, government, the armed forces, higher education, the elementary and secondary schools, as well as the general public, to focus attention on this problem of great national concern. In that regard, I like to think that California has rung the bell again.

We commend the Superintendent of Instruction and his associates in the State Department of Education and the State Board of Education for conceiving, planning, and directing this conference. We commend those organizations and individuals who have participated in the conference at their own expense. This kind of participation shows great interest, real concern, and desire to co-operate in finding solutions to common problems. The conference has been fortunate, I think, in the choice of persons to present the formal statements, with the possible exception of the one who is now speaking. It is obvious that each is an authority in his own field.

The luncheon and dinner provided for the conference participants yesterday were made possible through the generosity of several important California industries. Industry, particularly in southern California, has played a tremendous part in the teamwork that has been going on with the schools. The press has given excellent coverage of the conference activities. Not the least of the physical features of the conference was the thoughtful provision of busses to keep us on schedule and to protect us from the liquid sunshine.

I thought I detected a high degree of objectivity in this conference. There was little attempt to place blame and a serious desire to get at facts. Not everyone saw

eye to eye, but I felt that there was a spirit of wanting to disagree agreeably whenever differences of opinion were voiced. There were those who seemed to be pretty well satisfied with what the schools have been and are doing and those who probably wanted some kind of so-called "crash program." It was generally recognized that there is no single cause for our national dilemma, nor will there be any single cure or solution.

We have been helped to see the problem in all its complexities. Our technological revolution was underscored by Dr. Seaborg. The ensuing manpower problem was vividly portrayed by Dr. Meyerhoff, Mr. Mohn, and Mrs. Wickens. The low birth rate during the depression and the resulting low ebb of manpower today are important factors that are frequently overlooked. Discussions of the dramatic development of atomic energy, the acceleration of automation in industry, the launching of the Russian Sputnik, and our psychological tailspin and partial recovery have helped us to see how we got into the problems with which we are now dealing. We have been helped in this conference to see some of the many factors that have converged to bring us to our current position. We have been brought to recognize more clearly that it will take the co-operative efforts of all to meet properly the challenge of developing higher levels of skilled personnel in all phases of our economy. I suppose it is also human nature for us to be "down" on what we are not "up" on. Someone else put it this way—that to understand all means to forgive all. I believe this conference has helped us to see each other's problems and each other's roles and to think through areas of need wherein we can work co-operatively to the greatest advantage.

I thought that the reports (and this is where I inject a little of personal prejudice, perhaps) on what schools are actually doing in the fields of science and mathematics were both enlightening and encouraging. Although the figures brought out in the reports have not been given much national publicity, in the past five years there has been a tremendous forward surge in the teaching of science and mathematics at both the high school and the junior college level. I suspect that the schools aren't doing as badly as some of their more ardent critics claim. But in the light of today's needs for skilled workers, neither are the schools doing as well as we hoped they were. At this conference school personnel seemed to be less on the defensive than usual, thanks to the quality of the manpower and womanpower—both from the schools and from outside the schools—who took part in the meetings.

I think one of the reasons school people have generally been on the defensive so much is because certain irresponsible critics have been busy in a campaign to belittle the schools and to berate administrators as educationists. These critics have preached a lot of nonsense in which they claim that "progressive education" (that is the label they use) has disregarded the fundamental skills and promoted unrestricted pupil freedom. I know no responsible educator who believes in this nonsense. I suggest that the best way to help such people see the light is to invite them to come and observe what the schools are doing and to stop "beating a dead horse." I frequently remind my fellow administrators that at least half the lies that have been told about the schools aren't true. This in itself indicates that I need to improve on my mathematics a little. The most greatly needed attribute of a school superintendent today is to have the hide of a rhinoceros.

I thought I recognized strong sentiment in this conference against a so-called "crash program." Nevertheless the conferees have been very much aware of the important place of science and mathematics in today's liberal arts program—a pro-

gram of education for all—and of the need for a stepping-up of training to ensure an increasing number of high-level scientists and engineers. Mrs. Wickens pointed out yesterday that more and more vocations require higher technical competence, and Dr. Seaborg challenged the schools to equip from 30 to 50 per cent of our high school young people for rigorous work in fields requiring high degrees of scientific and technological competence. Science and mathematics have become increasingly important for all citizens—producers and consumers.

Some very important points have been brought out in this conference, and I wish to take this opportunity to summarize them.

Teachers must have greater prestige locally and nationally than they now have. In Russia the teacher is at the pinnacle of national prestige. The greatest need today is for quality teaching. We will get quality teaching when we have quality teachers. We will have quality teachers when we are willing to pay teachers salaries that compete with salaries in other fields of endeavor and that are adequate for teachers to maintain living standards that further their prestige.

Salaries for teachers must be such as to attract and hold individuals who are outstandingly competent. If states and local school districts are unwilling to pay what is necessary, then Uncle Sam will step in to ensure national survival and security.

Class size must be reduced to a teacher-pupil ratio that makes it possible for teachers to give the individual attention pupils need. We are told that in Russia the teacher-pupil ratio is 1 to 17. The big problem facing public education in our country is created by mass education. It has nothing to do with progressive education.

There should be more and better counseling and guidance to help students find their way into vocations in which individuals with their capacities and interests will most likely succeed and enjoy their work. In Russia guidance is provided only in the form of directives and force. I think it's very true that in the past five years the increased enrollments of high school and junior college students looking toward high levels of technical competence have been the result of our national crisis, parental influence, and improved counseling.

I would say that to achieve the four objectives I have thus far mentioned—building teacher prestige, offering adequate salaries to secure and retain teachers who are highly competent, reducing class size to permit the provision of individual instruction where this is needed, and providing adequate and appropriate counseling for all students—would take more money than is now available for education. But to fail to achieve these objectives will, in many instances, perpetuate glorified baby-sitting.

The best possible use should be made of the opportunities available during summer months for extending and strengthening the educational program, and wherein possible the schools and industry should work co-operatively toward this end. Many things have been said during this conference about programs of this kind. Therefore, I will take only the time needed to call your attention to the fact that many such programs of co-operation are going on throughout the country.

The possible extension of the length of the school day and that of the school year should be given serious consideration. Several specific additions to the curriculum have been proposed, but very few specific deletions have been suggested. Mathematics and science textbooks and instructional materials, particularly at the high school level, must be improved.

The high school elective system needs possible revamping. We have heard several points of view regarding this problem. The other day we heard Governor Knight propose that more of the school curriculum be mandated; and at the same time one of our great newspapers in the southern part of the state proposed that it might be wise to have more local autonomy. This is a problem that has not been settled. Its solution will depend upon the policy people wish to adopt. Probably wise counseling would prove to be more effective than other means as a way of getting the desired results.

If it is true that one-half of the additional labor force for the next ten years—an addition of ten million workers—will be women, then there should be ample provision at the secondary school and university levels wherein women will have opportunity to become proficient in the various skills they will need in the vocations of their choice. I would invite our friends at the university level to consider the best ways of making this provision—to take whatever steps may be necessary to provide educational programs that will equip women to render the highest possible service in professional, industrial, and technical fields. In many countries such steps are being taken with considerable success.

Full attention needs to be given to utilizing to a greater extent the services of master teachers through educational television, special workshops for teachers, and the like.

Special emphasis should be given to the retraining of elementary school teachers in the teaching of arithmetic. This point was made by Dr. Seaborg. As a former teacher of mathematics, I was hit between the eyes with this proposal because I hold the opinion that the teaching of arithmetic is one of the weak spots in our whole program of instruction.

There should be more teamwork between schools of education and the other disciplines at the university level. To find a good balance between the contributions these various fields can make should be our common goal. This teamwork might result in a sound solution for the problem of the so-called over-proliferation of professional education courses.

The general public should be encouraged to demand quality education and to be willing to pay for it. This involves building a respect for high competence all along the line. And I would remind you again that the schools tend to reflect the society of which they are a part. For many generations the attitude of the American parent has been something like this: "I don't want my boy to work like I had to." And so we tend to shelter our youngsters. Perhaps we have to recognize that we are now living in a pioneer age that demands some pioneer qualities.

In trying to attain all these goals, and other goals as well, we must everlastingly keep in mind the need for a balanced educational program for all boys and girls. That necessity has been echoed several times this afternoon. In spite of the newer curriculum emphases called for by our dramatic scientific revolution, the American dream is still to help each boy and girl to become the best that he is capable of becoming. This means that together we must, on the one hand, meet the nation's manpower needs and, on the other hand, help each individual to find his proper place in the sun. The test of our maturity, now and in the future, will be the degree to which we exercise a minimum of self-concern and possess maximum concern for what is best for the nation, its educational system, its individual citizens.

Let us take heart that neither the nation nor its schools have yet fallen apart. We have a strong economy, with great productivity, high standards of living, and

an excellent defense system. I like to recall that an eminent Brazilian came to America during World War II to study what it was that caused American vitality and strength. He concluded that the cause was neither our resources nor our great middle class (which is really an effect rather than a cause), but the fact that we have so many well-trained persons in all lines of activity. He said that this fact was due to our system of universal education—an attempt to develop the capacities of all.

The public schools cherish the co-operation of industry, higher education, and all the other agencies and organizations represented at this conference. With such co-operation, educational leadership at the state, county, and district level will continue to meet the challenge of our times. With your understanding and your help, leaders in the field of education will continue to appraise the programs offered by the schools to assess the needs of the schools, to determine strengths and weaknesses of the schools, to establish priorities, and to make necessary improvements toward the end that our people can develop the technical skills needed to forward our economy and defend our freedoms and at the same time to develop those qualities of citizenship that will make our civilization truly worth saving.

To my way of thinking, this has been a productive conference, one that points the way to better things. I would hope that at four o'clock this afternoon we will not conclude that we have finished our job, but rather that we have made the beginning of some fine accomplishments to come. I would close by paraphrasing the words of President Andrew Johnson who, when leaving the White House at a hectic time of challenge not unlike that of today (and he might well have been speaking to a group like ours), made this statement: "Fellow educators, you have the highest of human trusts committed to your care. Providence has showered on this favored land blessings without number and has chosen us as the guardians of freedom to preserve it for the benefit of the human race. May He who holds in His hands the destinies of nations make you worthy of the favors He has bestowed and enable you with pure hands and pure heart and sleepless vigilance to guard and defend to the end of time the great charge He has committed to your keeping."

## EDUCATION LOOKS AHEAD

**ROY E. SIMPSON,** ***Superintendent of Public Instruction***

This conference has truly focused the attention of California and the nation upon the importance of education in today's world. The conference has disclosed the fact that there is much that is good in our education today. It has also disclosed that there is great opportunity for more people to become better informed about school facility needs and teacher shortages. Knowledge about these things is important, but no more so than the disclosure that the pattern of education existing in California today has received wide public approval.

The responsibility for change, where change is needed, can be brought about without the destructive comments that seem to be so prevalent during this period of re-evaluation of our educational program. An example of such destructive criticism took place recently when a TV program singled out one of our fine schools in Los Angeles County, and attacked it unfairly. I'm happy to report that acknowledgment of error, in this instance, has been made. It is not necessary to destroy confidence in public education in order to improve our product.

We have taken stock of our schools. We confess to our strengths and to our weaknesses. We have measured our programs. We have some constructive suggestions and recommendations. I would conclude then that we look ahead to the following actions, among others, to improve the situation.

1. Stimulate more and better guidance for all youth, because the earlier we discover talent the better our chances are to develop such talent.

2. Elevate the status of the teacher in every branch of our educational structure by means of better salary schedules, and through honest praise of service well done.

3. Re-examine our entire teacher training program, including the credentialing of teachers. (California is now undergoing this process.)

4. During the period of readjustments in and study of teacher recruitment procedure, we must give opportunity to recognized degree candidates to teach in our classrooms, on some type of permit basis. This need not be looked upon as a lowering of our standards because these same people can qualify later, upon fulfilling credential requirements.

5. We must re-evaluate our present legal minimum curriculum standards in our elementary and secondary schools. It may be that special interest groups, or well-meaning citizens and legislators, as well as educators, have permitted the curriculum to be crowded to the degree that the school day does not permit sufficient emphasis upon science and mathematics in a well-balanced program.

Sufficient authority already exists in the Education Code [1] to permit local school boards (with the approval of the State Board of Education) to prepare courses of study for high schools, including junior high schools, suited to local needs. The State Legislature from time to time has seen fit to add certain courses to the school curriculum. I would hope that you and all reasonable citizens would seriously question, as I do, any attempt to impose a crash program upon our

[1] Education Code Sections 10501 through 10504. Section 10505 requires that each high school district shall maintain in one or more of its day high schools a course of study designed to prepare prospective students for admission to state colleges and the state university.

schools. Personally, I have great confidence in our school boards and the people they represent, and I believe that we can depend upon their good judgment without placing any additional state requirements upon the school districts.

6. Endeavor to anticipate needs in and train our product for general areas of knowledge and activity in such a manner that business, industry and the military will be relieved of much on-the-job training.

7. Hold fast to the many good things we know already exist in our public education. There is no room for discouragement in a country like America. Some feelings have been hurt, but let's be fair and honest in assessing the blame. The youth of California are willing and ready to undertake every good assignment. Our past records of achievement are superior. It is for us adults to reassess our own thinking in a new era in which youth already is outclassing us.

Fifteen of the 16 key scientists who developed the Explorer satellite at the California Technical Jet Propulsion Laboratories are graduates of American public schools; and 10 of these 15 are California public high school graduates.

8. We need to examine the law establishing the length of the school day as well as the school term. There are many issues involved in such a study, one of which is financial.

I know I speak for all interested in public education when I sincerely thank each and every one of you for your participation in this conference.

The wholesome stock taking that has been done will surely be of great value to our schools.

# Departmental Communications

## *OFFICE OF THE SUPERINTENDENT OF PUBLIC INSTRUCTION*

ROY E. SIMPSON, *Superintendent*

### APPOINTMENT TO STAFF

DON R. YOUNGREEN was appointed Assistant Chief, Division of State Colleges and Teacher Education, April 8, 1958, to replace Hubert H. Semans, who resigned to accept the position of Dean of Instruction, Foothill Junior College, Los Altos. Mr. Youngreen, graduated from Stanford University in 1930, engaged in private business until 1953, when he accepted employment with the Department of Finance. Later, he engaged in financial research for the planning survey branch of the Division of Highways, Department of Public Works. He served from 1943 to 1946 in the United States Army.

Since 1946, in his capacity as fiscal officer, Division of State Colleges and Teacher Education, Mr. Youngreen has had direct responsibility for the financial and business management affairs of the state colleges.

### REGULATIONS ADOPTED BY DIRECTOR OF EDUCATION

*Vending Stands for the Blind.* The Director of Education and the Bureau of Vocational Rehabilitation of the State Department of Education, acting through the Chief of the Bureau and with the approval of the Director of Education, acting under the authority of Government Code Section 6904 and Education Code Section 9897, and implementing Government Code Sections 6900 through 6909 and Education Code Section 9897, added Section 7005.5 to, and amended Sections 7006, 7009, 7020, 7021, 7022, 7033, and 7051 of Title 5 of the California Administrative Code, relating to vending stands for the blind, effective as of April 29, 1958.

The complete text of the added and amended sections of Title 5 of the California Administrative Code noted above will appear as reprints from the California Administrative Register, and will be available from the State Department of Education.

*Vacations for State College Employees.* The Director of Education, acting under the authority of Education Code Section 20251, amended Section 967 of Title 5 of the California Administrative Code, relating to vacations for state college employees, effective as of April 24, 1958.

The complete text of the amended sections of Title 5 of the California Administrative Code noted above will appear as reprints from the California Administrative Register, and will be available from the State Department of Education.

# For Your Information

## ANNUAL MEETING OF THE ENGINEERING EDUCATION SOCIETY

The American Society for Engineering Education will conduct its national annual meeting at the University of California, Berkeley, during the week of June 16-20, 1958. Members are expected to attend from all parts of the United States, Canada, Alaska, and Hawaii.

The program of the meeting will hold interest for college teachers in mathematics, science, English and the humanities; high-school teachers in these same fields; counselors and administrators in high schools, junior colleges and four-year colleges; and teachers and administrators of junior college and four-year engineering programs. Persons from industry and government will also attend and some of them will appear as speakers and members of panel discussions.

There will be programs concerned with the various branches and divisions of engineering practice; with aspects of engineering education, such as co-operative education, educational methods, evening programs and relations with industry; and with fields related to engineering, such as English, humanities, social sciences, mathematics, and physics.

Of special importance at this annual meeting will be the presentation of the final report on the Society's National Survey of Technical Institute Education. The survey was a grant from the Carnegie Corporation. It investigated the present status, trends and special problems in the education and employment of engineering technicians. The final report will be available for distribution about the time of the meeting. The report will facilitate study of the two-year technician programs offered in California, by many public junior colleges and several private technicial institutes, and similar programs offered in other parts of the nation.

It is not necessary to belong to the Society in order to attend its annual meetings. All persons interested in engineering education are invited to attend. Members will receive advance copies of the complete program for the meeting and forms for reserving housing accommodations for themselves and their families. Non-members who wish to attend may obtain information about housing facilities from Professor E. Paul DeGarmo, Department of Engineering, University of California, Berkeley 4, or from the Housing Bureau of the Chamber of Commerce, Berkeley.

o

75351 5-58 15,500 *printed in* CALIFORNIA STATE PRINTING OFFICE

# DIRECTORY OF THE CALIFORNIA STATE DEPARTMENT OF EDUCATION

## STATE BOARD OF EDUCATION

| | Term Expires January 15 |
|---|---|
| William L. Blair, *President*, Pasadena | 1960 |
| Wilber D. Simons, *Vice President*, Redding | 1960 |
| Byron H. Atkinson, Los Angeles | 1961 |
| William N. Bucknam, Ceres | 1959 |
| Raymond J. Daba, Redwood City | 1962 |
| Dr. Mabel E. Kinney, Los Angeles | 1962 |
| Mrs. Seymour Mathiesen, Fresno | 1962 |
| Mrs. Eva C. Noland, Salinas | 1960 |
| Max Osslo, San Diego | 1957 |
| William G. Werner, Alameda | 1959 |

Roy E. Simpson, *Secretary and Executive Officer*

## STAFF

(Unless otherwise indicated, all staff members may be reached at the State Education Building, 721 Capitol Avenue, Sacramento 14)

SUPERINTENDENT OF PUBLIC INSTRUCTION
Roy E. Simpson, *Superintendent of Public Instruction and Director of Education*
Dale P. Wren, *Special Assistant to the Director of Education*
Laurence D. Kearney, *Administrative Adviser*
Mrs. Jane Hood, *Assistant to the Superintendent*, 807 State Building, Los Angeles 12
Don W. Parks, *Field Representative*
George E. Hogan, *Deputy Superintendent; Chief, Division of Departmental Administration*
Francis W. Doyle, *Deputy Superintendent; Chief, Division of Special Schools and Services*
Samuel W. Patterson, *Assistant Division Chief*
Jay Davis Conner, *Associate Superintendent; Chief, Division of Instruction*
J. Burton Vasche, *Associate Superintendent; Chief, Division of State Colleges and Teacher Education*
Donald R. Youngreen, *Assistant Division Chief*
Wallace W. Hall, *Associate Superintendent; Chief, Division of Public School Administration*
Ronald W. Cox, *Assistant Division Chief*
ADMINISTRATIVE SERVICES, Bureau of, Marion B. Sloss, *Chief*
ADULT EDUCATION, Bureau of, Stanley E. Sworder, *Chief*
AGRICULTURAL EDUCATION, Bureau of, Byron J. McMahon, *Chief*
AUDIO-VISUAL EDUCATION, Bureau of, Francis W. Noel, *Chief*
BLIND, FIELD REHABILITATION SERVICE FOR THE, Bernece McCrary, *Supervising Field Worker*, 515 Van Ness Avenue, San Francisco 2
BUSINESS EDUCATION, Bureau of, R. C. Van Wagenen, *Chief*
CREDENTIALS OFFICE, Herschel S. Morgan, *Supervising Credentials Technician*
EDUCATION RESEARCH, Bureau of, Henry W. Magnuson, *Chief*
ELEMENTARY EDUCATION, Bureau of, Helen Heffernan, *Chief*
ELEMENTARY TEXTBOOK DISTRIBUTION, Burriss E. Claypool, *Supervisor*
GUIDANCE, Bureau of, Wm. H. McCreary, *Chief*
HEALTH EDUCATION, PHYSICAL EDUCATION, AND RECREATION, Bureau of, C. Carson Conrad, *Chief*
HOMEMAKING EDUCATION, Bureau of, Mrs. Dorothy M. Schnell, *Chief*
INDUSTRIAL EDUCATION, Bureau of, Samuel L. Fick, *Chief*
JUNIOR COLLEGE EDUCATION, Bureau of, Hugh G. Price, *Chief*
LIBRARIES, Division of, Mrs. Carma R. Zimmerman, *State Librarian*, Library and Courts Building
READJUSTMENT EDUCATION, Bureau of, Herbert E. Summers, *Chief*
SCHOOL APPORTIONMENTS AND REPORTS, Bureau of, Ray H. Johnson, *Chief*
SCHOOL DISTRICT ORGANIZATION, Bureau of, Drayton B. Nuttall, *Chief*
SCHOOL LUNCH PROGRAM, James M. Hemphill, *Supervisor*
SCHOOL PLANNING, Bureau of, Charles D. Gibson, *Chief*
SECONDARY EDUCATION, Bureau of, Frank B. Lindsay, *Chief*
SPECIAL EDUCATION, Bureau of, Ernest P. Willenberg, *Chief*
SUPPLEMENTAL EDUCATION SERVICES, Donald E. Kitch, *Chief*
SURPLUS PROPERTY, STATE EDUCATIONAL AGENCY FOR, William Farrell, *Chief Surplus Property Officer*
TEACHER EDUCATION, Carl A. Larson, *Specialist*
TEACHER RECRUITMENT, Blair E. Hurd, *Co-ordinator*
TEXTBOOKS AND PUBLICATIONS, Bureau of, Ivan R. Waterman, *Chief*
VOCATIONAL EDUCATION, Wesley P. Smith, *State Director*
VOCATIONAL REHABILITATION, Bureau of, Andrew Marrin, *Chief*